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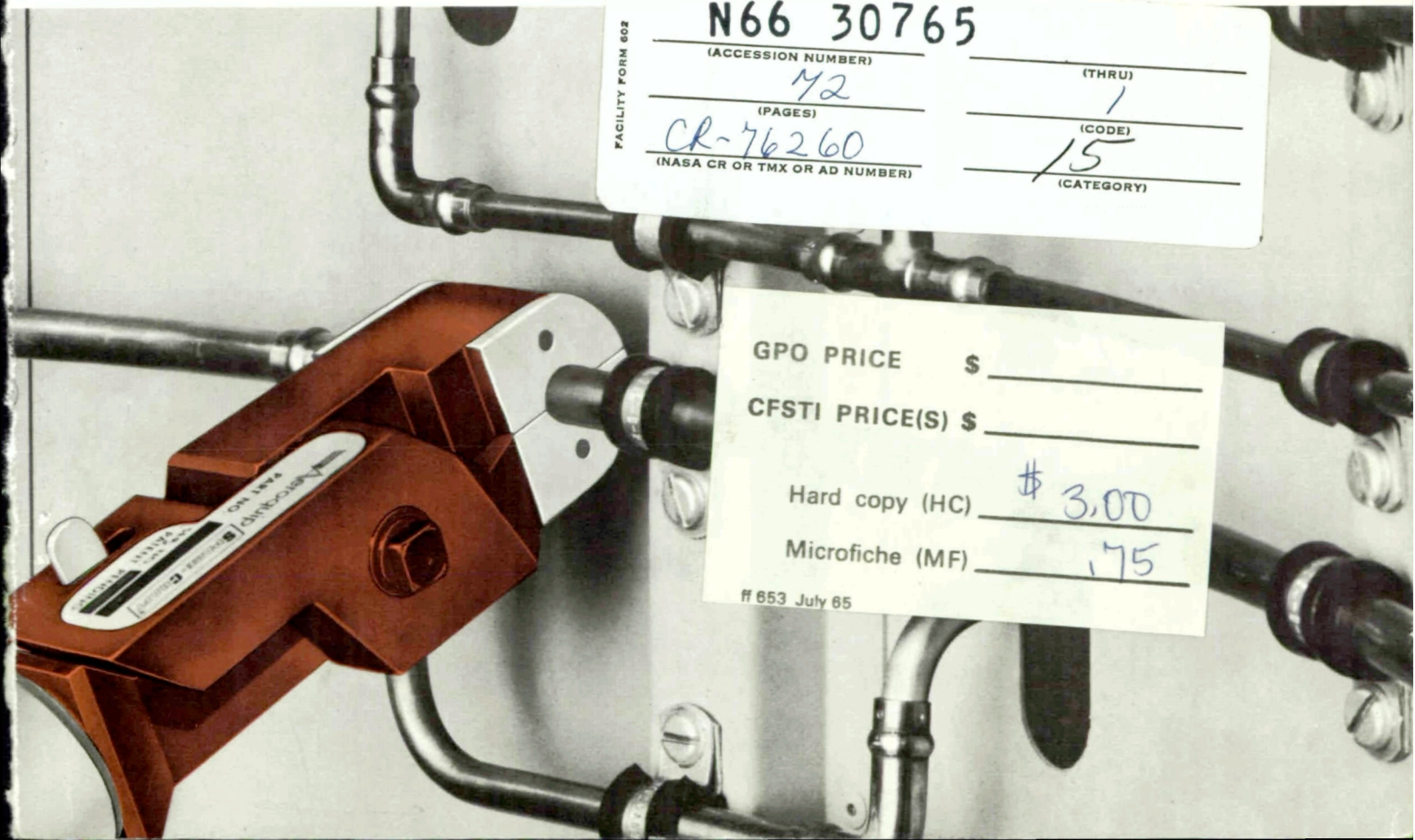

ELBEECO ENGINEERING PROJECT
NO. 37-3

REPORT OF TEST ON THE EVALUATION OF MOUNTING METHODS AND DISTANCES FOR AEROQUIP Space-Craft BRAZED TUBING ASSEMBLIES

TEST PERFORMED BY: AEROQUIP CORPORATION
TEST AUTHORIZED BY: NASA-MSFC
CONTRACT NO. NAS8-11336

	Date	Signature
Test Initiated	30 March 1965	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Test Completed	23 December 1965	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Report Written By	31 January 1966	P. H. Zimmer
Test Engineer	23 December 1965	Robert J. Siefka
Supervisor	31 January 1966	D. Takacs
Final Release	31 January 1966	XXXXXXXXXXXXXXXXXXXXXXXXXXXXX

REVISIONS			
REV.	DATE	APPROVED BY	PAGES AFFECTED AND DESCRIPTION
A	5/17/66	[signature]	Pages 2 through 6 and Pages 29 through 63 changed "ADEL 479" to "MS 21919". Page 9, added "Figures 9, 10 and 11". Page 14, Paragraph 2.4, added "three types of". Paragraph 6.1.2, added "burst pressure","A hand Blackhawk pump was used for pressurization during vibration." "The gage is a 3000 psi gauge with an accuracy of ± 1%. Paragraph 6.1.4, added weight of the Exciter Table, "40 lbs." Page 17, Paragraph 7.5.1, added "See Figure 9", "using a Blackhawk hand pump with an 3000 psi gauge." Page 18, Paragraph 7.5.3.1, deleted "(2 X A)", added "See". Paragraph 7.5.3.2, "where possible". Page 20, Paragraph 8.4, added "The failure of all clamps occurred during high level resonance dwell or sweeps." Page 26, deleted "45° elbow" vibration test orientation. Page 27, deleted "45° elbow" and "cross", vibration test orientation. Page 28, changed from "Silicone Rubber - LS 53" to "Butyl Rubber".

Aeroquip Corporation

ELBEECO PLANT, JACKSON, MICHIGAN

ENGINEERING DEPARTMENT

ELBEECO ENGINEERING PROJECT

NO. 37-2

TITLE

TEST PROCEDURE FOR THE EVALUATION OF MOUNTING METHODS AND DISTANCES FOR AEROQUIP Space-Craft BRAZED TUBING ASSEMBLIES. (NASA CONTRACT NAS8-11336)

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DATE June 14, 1965

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The signatures appearing below constitue approval of AEROQUIP CORPORATION Test Procedure EEP 37-2 as submitted to the National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Alabama

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Approval Received by: _____

_____

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1.0 INTRODUCTION

The manufacturing section (R-ME) of the Marshall Space Flight Center (MSFC) has been evaluating the brazed fitting concept for possible use on the Saturn vehicles. In February, 1964 Aeroquip completed an evaluation program on the 1/4-inch diameter 16000 psi burst pressure Space-Craft fitting and the 1/2-inch 6000 psi burst pressure fitting. The Aeroquip test report number is 60533, entitled "Induction Brazing Program Application and Evaluation".

The fittings were subjected to many types of tests, however, it was not advisable to run a vibration test since the vibration characteristics of the Saturn were not defined at that time. Since then, this information has become available and this test procedure has been written to cover this phase of the program.

1.1 Objectives

To determine the proper mounting materials for hold-down clamps.

To determine the proper hold-down clamp locations for fastening Space-Craft brazed tubing assemblies to achieve reliable performance when subjected to a specified vibration condition.

1.2 Scope

Since the distance between clamps and the type of clamps to be employed are very important, the primary purpose of this program will be to ascertain the preferred type of clamp to use as well as an optimum allowable distance between clamps for brazed fitting assemblies capable of 1500 psi operating pressure in sizes 1/4, 3/8, 1/2, 3/4, 1, 1 1/4 and 1 1/2 inches.

All of the testing will be done at Aeroquip Corporation, Jackson, Michigan.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this standard to the extent specified herein:

2.1 Government

MIL-H-5440D Hydraulic Systems, Aircraft, Types I and II, Design, Installation and Data Requirements For.

MIL-H-5606 Hydraulic Fluid, Petroleum Base, Aircraft Missile and Ordnance.

QQ-S-763C Steel Bars, Shapes, and Forgings, Corrosion - Resisting.

2.2 Society of Automotive Engineers Specification AMS 5557A, Steel Tubing, Corrosion and Heat Resistant, 18CR - 11Ni - Ti (SAE 30321) Hydraulic.

2.3 National Aeronautics and Space Administration.

NASA Contract NAS8 - 11336 for Evaluation of Mounting Methods and Distances for Aeroquip Brazed Tubing Assemblies.

2.4 American Welding Society

AWS 25,8 - 62T Brazing Filler Metal Class BAu-4.

2.5 Aeroquip Corporation

ACES 652 Tubing, Welded and Drawn CRES Steel 321, 1/8 Hard, Hydraulic.

2.6 Elbeeco Engineering Projects

EEP 403 - Brazing Procedure, Aeroquip Space-Craft Induction.

3.0 TEST REQUIREMENTS

3.1 Ambient Conditions

Unless otherwise specified all tests shall be conducted at ambient conditions of 77 ± 18°F Temperature 20, to 95% relative humidity and Sea Level to 24.05-inches Hg pressure.

3.2 Failure Definition

Failure shall be defined as any visible damage to, or leakage of, the test specimen.

3.3 Deviations

No changes shall be made in the requirements of the test procedure without written approval from the Contracting Officers Technical Representative for testing at NASA-MSFC.

3.4 Final Report

The final report shall include a chronological record of all testing and the results obtained. When a failure occurs, complete details of the testing conditions and a description of the failure shall be included.

An approved copy of the test procedure shall be included as an appendix in the final report.

4.0 COMPONENT DESCRIPTION

This test program will cover brazed fitting assemblies capable of 1,500 psi operating pressure with 6,000 psi minimum burst pressure for sizes from 1/4-inch through 1 1/4-inch and brazed fitting assemblies of the 1 1/2-inches size with a 1,500 psi operating pressure and 3,750 psi minimum burst pressure. There will be three different configurations for each size and three 36-inch long specimens per configuration consisting of unions, 90° elbows and tees. Refer to Figures 1-3 for the test specimen assembly specification drawings.

4.1 Space-Craft Brazing Fittings.

The fittings shall be standard Space-Craft fittings fabricated from AISI 321 stainless steel tubing procured to specification AMS 5557 (welded tubing). The brazing alloy shall be AWS BAu-4 gold-nickel alloy (82% gold, 18% nickel). The part numbers of the fittings are listed in Figures 1-3.

4.2 Run Tubing

The run tubing shall be AISI 321 stainless steel, welded and drawn, 1/8 hard, procured to ACES 652. The diameters and wall thicknesses of the run tubing are listed in Figures 1-3.

4.3 End Connections

These connections shall consist of "wired-on" type nuts attached to welded shoulders as shown in Figures 1-3.

(D) 4.4 Hold-Down Clamps

The hold-down clamps shall be of the MS 21919 design with butyl rubber, silicone rubber and stainless steel wire mesh as the cushioning materials or Adel #478 style clamps with stainless steel cushioning material.

4.5 Fabrication

After the run tubing is cut to length and the end connections attached, the fittings shall be brazed and inspected to the required procedure defined in EEP 403. The inspection includes a visual examination and radiographic analysis.

5.0 PROCEDURE

5.1 Pre-Test Inspection

5.1.1 Visual and Radiographic

The test specimens shall be visually inspected to insure proper brazing alloy flow and radiographically inspected to the requirements of EEP 403, Section 6.2.1.2.

5.2 Proof Pressure Test

The 1/4-inch through 1 1/4-inch test specimens shall be hydrostatically pressurized at 3,000 psig and the 1 1/2-inch test specimens at 2250 psig for a period of five minutes.

5.3 Mass Spectrometer Leak Detection Test

The test specimens shall be dried in an oven at 225 F for one hour and pressurized with helium to the specified operating pressure. Leakage shall be checked by use of a mass spectrometer and the leakage rate recorded.

5.4 Test Requirements for Space-Craft Brazed Tubing Assemblies

All test specimens shall be subjected to the following series of tests:

a. Proof Pressure Test

b. Mass Spectrometer Leak Test

c. Vibration Test

d. Mass Spectrometer Leak Test

e. Burst Test

5.5 Vibration Test

5.5.1 Testing Set-Up

The test specimens shall be tested individually by attaching them to a magnesium test fixture with the holddown clamps. The clamping shall be done in a consistent manner to eliminate as many variables as possible. All tests shall be conducted using hold-down clamps with a stainless steel mesh cushioning material. Additional high level sine sweep and random tests will be required on selected sizes using hold-down clamps with butyl and silicone rubber cushioning materials.

The test specimens shall be pressurized to 1500 psi with MIL-H-5606 hydraulic fluid during the vibration testing (See Figure 4).

5.5.2 Acceleration Measurement

The acceleration input control shall be accomplished by using an accelerometer at the test assembly-test fixture interface (See Figure 4). The output at the center of the specimen shall be monitored only during the low level sweeps.

5.5.3 Manner of Testing

5.5.3.1 Resonance Search and Sine Dwell Tests:

The first specimen of each size and configuration shall be attached to the vibration equipment with a clamping pitch distance of four inches. The specimens shall be oriented so the axis of greatest response is excited and shall then be subjected to resonance search and sine dwell vibration tests, the dwell being for one minute each at the levels specified in paragraph 5.6.2. Upon completion of this testing the clamping pitch distance shall be increased in four inch increments up to the maximum allowable in MIL-H-5440D, paragraph 3.11.28.8 for the same series of tests. The maximum clamping distances for the tubing sizes being tested are as follows:

1/4 inch - 16 inches

3/8 inch - 20 inches

1/2 inch - 23 inches

3/4 inch - 27 1/2 inches

1 inch - 30 inches

1 1/4 inch - 31 1/2 inches

1 1/2 inch - 32 1/2 inches

When a specimen fails, a new specimen shall be installed and a resonance search and dwell at the specified levels shall be performed at the same clamping distance as before. Should the second sample fail, the next lower increment just passed shall be the maximum clamping distance. Should the specimen not fail, then the maximum distance shall be that at which the specimen first exhibited a failure.

The third specimen shall be subjected to a sinusoidal sweep (logarithmically) 5-2000-5 cps at 1.0 octave/minute at the dwell levels outlined under paragraph 5.6.2 at the predetermined clamping distance in each of the major specimen axes. All resonant frequencies shall be recorded.

5.5.3.2 Random Vibration

The third speciman of each size and configuration shall be vibrated as specified in paragraph 5.6.3 using hold-down clamps with butyl rubber and silicone rubber cushioning materials in addition to the clamps used in the previous series of tests.

5.6 Environmental Tests

5.6.1 Resonance Search

All test specimens from the 1/4-inch to the 3/4-inch size shall be vibrated with inputs at the control accelerometers as follows:

5 to 22 cps - 0.075-inch D.A.
22 to 2000 cps - ±2g (Peak)

All test specimens from the 1-inch to 1 1/2-inch size shall be vibrated with inputs at the control accelerometers as follows:

5 to 28 cps - 0.075-inch D.A.
28 to 2000 cps - ±3g (peak)

Ⓒ 5.6.2 Resonance Dwell

The test specimens shall be vibrated for one minute each at the two major resonances in the most severe axis at the following levels:

5 to 32 cps - 0.58-inches D.A.
32 to 76 cps - ±30g (peak)
76 to 125 cps - 0.100-inches D.A.
125 to 2000 cps - ±80g (peak)

This spectrum should be followed to machine capacity.

Ⓓ 5.6.3 Random Vibration

If the specimen fulfills the above sinusoidal levels of testing, then it shall be vibrated additionally as follows for five minutes in the most severe axis:

20 to 55 cps - $1.5g^2$ /cps
55 to 100 cps - +6.0 db/oct.
100 to 1340 cps - $5.0\ g^2$ /cps
1340 to 2000 cps - -9.0 db/oct.
2000 cps - $1.5\ g^2$ /cps

This spectrum may be split as necessary but under no circumstances shall the spectrum be split near a major resonance frequency.

5.7 In-Process Inspection

Following each phase of the vibration tests the test specimens shall be visually examined for evidence of damage or deterioration. If damage is suspected the test specimen shall be subjected to a mass spectrometer leak detection test. Results of all inspections shall be included in the test report.

5.8 Post-Test Inspection

Following the vibration tests the test specimens shall be subjected to visual examination, the proof pressure test as described in paragraph 5.2 and mass spectrometer leak detection test as described in paragraph 5.3. Results of these inspections shall be included in the test report.

5.9 Burst Test

The test specimens shall be pressurized to proof pressure and maintained for five minutes using MIL-H-5606A hydraulic fluid at room temperature. The pressure shall be slowly increased to 6000 psi for the sizes less than 1 1/2 inches and 3750 psi for the 1 1/2 inch specimens and maintained for five minutes. The pressure shall then be slowly increased to rupture. All burst test specimens shall be submitted to MSFC with the test report. The pressure at which deformation occurs shall be noted.

6.0 TEST EQUIPMENT

6.1 Radiographic

The equipment to be used is a Westinghouse Dynamax, 150 KW, No. HK11A, with a focal spot of 1.0MM. This unit has a sensitivity of 2% and a maximum capacity of 1/2-inch of stainless steel.

6.2 Pressure

The equipment to be used is an Aeroquip designed test stand equipped with a high pressure pump of 10000 psig with an 8:1 ratio intensifier. The pressure gauge will have a range of 0 to 30000 psi and an accuracy of ±1%.

6.3 Leak Detection

The equipment to be used is a Veeco Mass Spectrometer leak detector, Model MS-9AB, which has a detectable leak rate of 2.7×10^{-10} atmos. cc/sec. helium with a negative pressure capability of 1×10^{-6} Torr.

6.4 Vibration

The machine to be used is an Electrodynamic Vibrator, Ling Model A300 with an ASDE40 (45 channel) automatic random noise rack. The equipment has the following capabilities:

Acceleration, Maximum ±100g's peak
Amplitude, Maximum. 1.0 in. peak to peak
Velocity Limit: 70 in. per second
Axial Suspension Stiffness: 1000 lb. per in.
Exciter Table: 13-1/4 in. diameter
Slip Table: 30 X 48 in.

	Sinusoidal	Random
Force:	6000 lb. peak	3200 lb. rms
Frequency Range:	5 - 3000 cps	20-2000 cps
Table Load, Max:	560 lb. at 10 g peak	280 lb. at 10 g rms
	160 lb. at 30 g peak	67 lb. at 30 g rms
	80 lb. at 50 g peak	24 lb. at 50 g rms
	20 lb. at 100 g peak	10 lb. at 64 g rms

Aeroquip Corporation

ELBEECO PLANT, JACKSON, MICHIGAN
ENGINEERING DEPARTMENT

TEST SUMMARY SHEET

SPECIMEN NUMBER	TYPE OF SPECIMEN	VISUAL AND RADIOGRAPH INSPECTION (PARA. 7.1)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	RESONANCE SEARCH VIBRATION TEST (PARA. 7.5.3.1 7.6.1)	SINUSOIDAL DWELL VIBRATION TEST (PARA. 7.5.3.1 7.6.2)	SINUSOIDAL SWEEP VIBRATION TEST (PARA. 7.6.2)	RANDOM VIBRATION TEST (PARA. 7.5.3.2 7.6.3)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	BURST TEST (PARA. 7.9)	CLAMP USED AND RESULTS
NF 1-2	SKEL 867-4 1/4-in. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near The Middle At 18000 Psi	- - -
NF 3-4	SKEL 867-4 1/4-in. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near The Middle At 17750 Psi	- - -
NF 5-6	SKEL 867-4 1/4-in. Union	Satisfactory	No Leakage	No Leakage	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Near The Middle At 17500 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NF 7-8	SKEL 868-4 1/4-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Near The Inside Of The Bend At 13750 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion Failed - Completed With Butyl Rubber Cushion
NF 9-10	SKEL 868-4 1/4-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near The Inside Of The Bend At 14000 Psi	- - -
NF 11-12	SKEL 868-4 1/4-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At The Outside Of The Bend At 14000 Psi	- - -
NF 13-14-15	SKEL 869-4 1/4-in. Tee	Satisfactory	No Leakage	No Leakage	12-in. Clamping Distance No Failure	12-in. Clamping Distance No Failure	12-in. Clamping Distance No Failure	12-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed In Drop Leg At 16250 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NF 16-17-18	SKEL 869-4 1/4-in. Tee	Satisfactory	No Leakage	No Leakage	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance - Failed At 100 cps, 80g	None	None	None	None	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NF 19-20-21	SKEL 869-4 1/4-in. Tee	Satisfactory	No Leakage	No Leakage	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance - Failed At 125 cps, 80g	None	None	None	None	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NH 1-2	SKEL 867-6 3/8-in. Union	Satisfactory	No Leakage	No Leakage	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	No Leakage	No Leakage	Tube Failed Adjacent To The Fitting Near Joint NH2 At 19000 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NH 3-4	SKEL 867-6 3/8-in. Union	Satisfactory	No Leakage	No Leakage	20-in. Clamping Distance No Failure	20-in. Clamping Distance - Failed at 127 cps, 80g	None	None	None	None	None	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NH 5-6	SKEL 867-6 3/8-in. Union	Satisfactory	No Leakage	No Leakage	20-in. Clamping Distance No Failure	20-in. Clamping Distance - Failed at 126 cps, 80g	None	None	None	None	None	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NH 7-8	SKEL 868-6 3/8-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed At The Outside Of The Bend At 15000 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure

TEST SUMMARY SHEET

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ENGINEERING DEPARTMENT

SPECIMEN NUMBER	TYPE OF SPECIMEN	VISUAL AND RADIOGRAPH INSPECTION (PARA. 7.1)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	RESONANCE SEARCH VIBRATION TEST (PARA. 7.5.3.1 / 7.6.1)	SINUSOIDAL DWELL VIBRATION TEST (PARA. 7.5.3.1 / 7.6.2)	SINUSOIDAL SWEEP VIBRATION TEST (PARA. 7.6.2)	RANDOM VIBRATION TEST (PARA. 7.5.3.2 / 7.6.3)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	BURST TEST (PARA. 7.9)	CLAMP USED AND RESULTS
NH 9-10	SKEL 868-6 3/8-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near The Side In The Bend At 14000 Psi	- - -
NH 11-12	SKEL 868-6 3/8-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At The Outside Of The Bend At 16000 Psi	- - -
NH 13-14-15	SKEL 869-6 3/8-in. Tee	Satisfactory	No Leakage	No Leakage	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	16-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Between The NH13 And NH14 Legs At 15750 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NH 16-17-18	SKEL 869-6 3/8-in. Tee	Satisfactory	No Leakage	No Leakage	20-in. Clamping Distance No Failure	20-in. Clamping Distance - Failed at 725 cps, 80g	None	None	None	None	None	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NH 19-20-21	SKEL 869-6 3/8-in. Tee	Satisfactory	No Leakage	No Leakage	20-in. Clamping Distance No Failure	20-in. Clamping Distance No Failure	20-in. Clamping Distance - Failed at 125 cps, 80g	None	None	None	None	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NJ 1-2	SKEL 867-8 1/2-in. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near The NJ2 End At 18000 Psi	- - -
NJ 3-4	SKEL 867-8 1/2-in. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near The NJ4 End At 18250 Psi	- - -
NJ 5-6	SKEL 867-8 1/2-in. Union	Satisfactory	No Leakage	No Leakage	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	No Leakage	No Leakage	Tubing Failed Adjacent To The Fitting Near The NJ6 End At 17250 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NJ 7-8	SKEL 868-8 1/2-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Near The Side Of The Bend At 13500 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NJ 9-10	SKEL 868-8 1/2-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near The Side Of The Bend At 13500 Psi	- - -
NJ 11-12	SKEL 868-8 1/2-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near The Outside Of The Bend At 13750 Psi	- - -
NJ 13-14-15	SKEL 869-8 1/2-in. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NJ13 And NJ14 Legs At 13250 Psi	- - -
NJ 16-17-18	SKEL 869-8 1/2-in. Tee	Satisfactory	No Leakage	No Leakage	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	23-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Between The NJ16 And NJ17 Legs At 12500 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure

TEST SUMMARY SHEET

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SPECIMEN NUMBER	TYPE OF SPECIMEN	VISUAL AND RADIOGRAPH INSPECTION (PARA. 7.1)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	RESONANCE SEARCH VIBRATION TEST (PARA. 7.5.3.1 / 7.6.1)	SINUSOIDAL DWELL VIBRATION TEST (PARA. 7.5.3.1 / 7.6.2)	SINUSOIDAL SWEEP VIBRATION TEST (PARA. 7.6.2)	RANDOM VIBRATION TEST (PARA. 7.5.3.2 / 7.6.2)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	BURST TEST (PARA. 7.9)	CLAMP USED AND RESULTS
NJ 19-20-21	SKEL 869-8 1/2-In. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NJ19 And NJ20 Legs At 14500 Psi	- - -
NL 1-2	SKEL 867-12 3/4-In. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near Joint NL1 At 17250 Psi	- - -
NL 3-4	SKEL 867-12 3/4-In. Union	Satisfactory	No Leakage	No Leakage	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	No Leakage	No Leakage	Tubing Failed Adjacent To The Fitting Near Joint NL4 At 17500 Psi	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion Failed- Completed With Silicone Cushion
NL 5-6	SKEL 867-12 3/4-In. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Near The Welded End Fitting At 17500 Psi	- - -
NL 7-8-9	SKEL 869-12 3/4-In. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NL7 And NL8 Legs At 15000 Psi	- - -
NL 10-11-12	SKEL 869-12 3/4-In. Tee	Satisfactory	No Leakage	No Leakage	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Between The NL10 And NL11 Legs At 15750 Psi	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Failure
NL 13-14-15	SKEL 839-12 3/4-In. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NL13 And NL15 Legs At 14000 Psi	- - -
NL 16-17	SKEL 868-12 3/4-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At The Outside Of The Bend At 13100 Psi	- - -
NL 18-19	SKEL 868-12 3/4-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At Inside Of The Bend At 12250 Psi	- - -
NL 20-21	SKEL 868-12 3/4-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed At Outside Of Bend At 13250 Psi	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Failure
NM 1-2	SKEL 867-16 1-In. Union	Satisfactory	No Leakage	No Leakage	30-In. Clamping Distance No Failure	30-In. Clamping Distance No Failure	30-In. Clamping Distance No Failure	30-In. Clamping Distance No Failure	No Leakage	No Leakage	Tubing Failed Adjacent To The Fitting Near Joint NM2 At 15500 Psi	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Failure
NM 3-4	SKEL 867-16 1-In. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Welded End Fitting Blew Off At 15500 Psi	- - -
NM 5-6	SKEL 867-16 1-In. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near Joint NM5 At 15500 Psi	- - -

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TEST SUMMARY SHEET

SPECIMEN NUMBER	TYPE OF SPECIMEN	VISUAL AND RADIOGRAPH INSPECTION (PARA. 7.1)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	RESONANCE SEARCH VIBRATION TEST (PARA. 7.5.3.3 / 7.6.1)	SINUSOIDAL DWELL VIBRATION TEST (PARA. 7.5.3.1 / 7.6.2)	SINUSOIDAL SWEEP VIBRATION TEST (PARA. 7.6.2)	RANDOM VIBRATION TEST (PARA. 7.5.3.2 / 7.6.3)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	BURST TEST (PARA. 7.9)	CLAMP USED AND RESULTS
NM 7-8-9	SKEL 869-16 1-in. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NM7 And NM9 Legs At 12000 Psi	- - -
NM 10-11-12	SKEL 869-16 1-in. Tee	Satisfactory	No Leakage	No Leakage	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	No Leakage	No Leakage	Welded On End Fitting Leaked At 11500 Psi	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Failure
NM 13-14-15	SKEL 869-16 1-in. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NM13 And NM15 Legs At 12500 Psi	- - -
NM 16-17	SKEL 868-16 1-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At 13000 Psi	- - -
NM 18-19	SKEL 868-16 1-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed At 12500 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure
NM 20-21	SKEL 868-16 1-in. Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At 12500 Psi	- - -
NN 1-2	SKEL 867-20 11/4-in. Union	Satisfactory	No Leakage	No Leakage	32-in. Clamping Distance No Failure	32-in. Clamping Distance No Failure	32-in. Clamping Distance No Failure	32-in. Clamping Distance No Failure	No Leakage	No Leakage	Tubing Failed Adjacent To The Fitting Near Joint NN1 At 14000 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion Failed - Completed With Solid Alum. 2 Hole Clamp
NN 3-4	SKEL 867-20 11/4-in. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near Joint NN4 At 14300 Psi	- - -
NN 5-6	SKEL 867-20 11/4-in. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near Joint NN5 At 15000 Psi	- - -
NN 7-8-9	SKEL 869-20 11/4-in. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NN7 And NN8 Legs At 12100 Psi	- - -
NN 10-11-12	SKEL 869-20 11/4-in. Tee	Satisfactory	No Leakage	No Leakage	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	30-in. Clamping Distance No Failure	32-in. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Between The NN10 And NN12 Legs At 12100 Psi	MS 21919 3/4-in. Wide CRES -Butyl Rubber Cushion Failed - Completed With Solid Alum. 2 Hole Clamp
NN 13-14-15	SKEL 869-20 11/4-in. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Between The NN13 And NN15 Legs At 12000 Psi	- - -
NN 16-17	SKEL 868-20 11/4-in. 90° Elbow	Satisfactory	No Leakage	No Leakage	321/2-in. Clamping Distance No Failure	321/2-in. Clamping Distance No Failure	32 1/2-in. Clamping Distance No Failure	32 1/2-in. Clamping Distance No Failure	No Leakage	No Leakage	Tubing Failed Adjacent To The Fitting Near Joint NN17 At 14750 Psi	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Failure

TEST SUMMARY SHEET

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ENGINEERING DEPARTMENT

SPECIMEN NUMBER	TYPE OF SPECIMEN	VISUAL AND RADIOGRAPH INSPECTION (PARA.7.1)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA. 7.3)	RESONANCE SEARCH VIBRATION TEST (PARA. 7.5.3.1 7.6.1)	SINUSOIDAL DWELL VIBRATION TEST (PARA. 7.5.3.1 7.6.2)	SINUSOIDAL SWEEP VIBRATION TEST (PARA. 7.6.2)	RANDOM VIBRATION TEST (PARA. 7.5.3.2 7.6.3)	PROOF PRESSURE TEST (PARA. 7.2)	MASS SPECTROMETER LEAK TEST (PARA 7.3)	BURST TEST (PARA 7.9)	CLAMP USED AND RESULTS
NN 18-19	SKEL 868-20 11/4-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Tubing Failed Adjacent To The Fitting Near Joint NN19 At 14500 Psi	- - -
NN 20-21	SKEL 868-20 11/4-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Welded On End Fitting Leaked At 13000 Psi - Couldn't Seal	- - -
NP 1-2	SKEL 867-24 11/2-In. Union	Satisfactory	No Leakage	No Leakage	32-In. Clamping Distance No Failure	32-In. Clamping Distance No Failure	32-In. Clamping Distance No Failure	32-In. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Near Internal Fillet At 12750 Psi	MS 21919 3/4-In. Wide CRES -Butyl Rubber Cushion Failed - Completed With Solid Alum. 2 Hole Clamp
NP 3-4	SKEL 867-24 11/2-In. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near Internal Fillet At 12500 Psi	- - -
NP 5-6	SKEL 867-24 11/2-In. Union	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed Near Internal Fillet At 12500 Psi	- - -
NP 7-8-9	SKEL 869-24 11/2-In. Tee	Satisfactory	No Leakage	No Leakage	33-In. Clamping Distance No Failure	33-In. Clamping Distance - Failed at 88cps, 41g	None	None	None	None	None	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Failure
NP 10-11-12	SKEL 869-24 11/2-In. Tee	Satisfactory	No Leakage	No Leakage	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	28-In. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed Between The NP10 And NP11 Legs At 8500 Psi	MS 21919 3/4-In. Wide CRES-Butyl Rubber Cushion Failed - Completed With Solid Alum. 2 Hole Clamp
NP 13-14-15	SKEL 869-24 11/2-In. Tee	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Welded On End Fitting Leaked At 8500 Psi Couldn't Seal	- - -
NP 16-17	SKEL 868-24 11/2-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At 10250 Psi	- - -
NP 18-19	SKEL 868-24 11/2-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	321/2-In. Clamping Distance No Failure	321/2-In. Clamping Distance No Failure	321/2-In. Clamping Distance No Failure	32 1/2-In. Clamping Distance No Failure	No Leakage	No Leakage	Fitting Failed At 10200 Psi	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Failure
NP 20-21	SKEL 868-24 11/2-In. 90° Elbow	Satisfactory	No Leakage	No Leakage	None	None	None	None	None	None	Fitting Failed At 10000 Psi	- - -

NOTICE

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APPENDICES

APPENDIX A - EEP 37.2 "Test Procedure For The Evaluation Of Mounting Methods and Distances For Aeroquip Space-Craft Brazed Tubing Assemblies (NASA Contract NAS8-11336)".

APPENDIX B - ACES 652 "Tubing, Welded and Drawn CRES 321, 1/8 Hard Hydraulic".

1. INTRODUCTION.

The manufacturing section (R-ME) of the Marshall Space-Flight Center (MSFC) has been evaluating the brazed fitting concept for possible use on the Saturn vehicles. In February 1964 Aeroquip completed an evaluation program on the 1/4-inch diameter 16000 psi burst pressure Space-Craft fitting and the 1/2-inch diameter 16000 psi burst pressure fitting. The Aeroquip test report number is 60533, entitled "Induction Brazing Program Application and Evaluation".

The fittings were subjected to many types of tests, however, it was not advisable to run a vibration test since the vibration characteristics of the Saturn were not defined at the time. Since then, this information has become available and this test has been conducted to evaluate brazed fittings when subjected to these vibration conditions.

1.1 Objectives.

To determine the proper mounting materials for hold-down clamps.

To determine the proper hold-down clamp locations for fastening Space-Craft brazed tubing assemblies to achieve reliable performance when subjected to a specified vibration condition.

1.2 Scope.

Since the distance between clamps and the type of clamps to be employed are very important, the primary purpose of this program is to ascertain the preferred type of clamp to use as well as an optimum allowable distance between clamps for brazed fitting assemblies capable of 1500 psi operating pressures in sizes 1/4, 3/8, 1/2, 3/4, 1, 1 1/4 and 1 1/2-inches.

All of the testing was done at Aeroquip Corporation, Jackson, Michigan.

2. COMPONENT DESCRIPTION.

This test program covered brazed fitting assemblies capable of 1500 psi operating pressure with 6000 psi minimum burst pressure for sizes from 1/4-inch through 1 1/4-inch and brazed fitting assemblies of the 1 1/2-inch size with a 1500 psi operating pressure and 3750 psi minimum burst pressure. There were three (3) different configurations for each size and three (3) 36-inch long specimens per configuration consisting of unions, 90° elbows and tees. Figures 1 through 3 on pages 21 through 23 are the test specimen drawings.

2.1 Space-Craft Brazing Fittings.

The fittings were standard Space-Craft fittings fabricated from AISI 321 stainless steel procured to specification AMS 5557 (welded tubing) and AMS 5645 (bar). The brazing alloy was AWS BAu-4 gold-nickel alloy (82% gold, 18% nickel). The part numbers of the fittings are listed in Figures 1 through 3.

2.2 Run Tubing.

The run tubing was AISI 321 stainless steel, welded and drawn, 1/8 hard, procured to ACES 652. The diameters and wall thicknesses of the run tubing are listed in Figures 1 through 3.

2.3 End Connections.

These connections consisted of "wired-on" type nuts attached to welded shoulders as shown in Figures 1 through 3.

2.4 Hold-Down Clamps.

The three (3) types of hold-down clamps were of the MS 21919 ADEL 479 or two (2) hole aluminum (See Figure 8) designs as noted in the summary with butyl rubber, silicone rubber and stainless steel wire mesh as noted, as the cushioning materials.

2.5 Fabrication.

After the run tubing was cut to length and the end connections attached, the fittings were brazed and inspected to the required procedure defined in ACES 403. The inspection included a visual examination and radiographic analysis.

3. DISPOSITION OF TEST SPECIMENS.

The test specimens are being submitted to NASA-MSFC with this test report.

4. NARRATIVE ABSTRACT CONCLUSIONS AND RECOMMENDATIONS.

The MS 21919 and ADEL 479 clamps failed on the larger size tubing and two (2) hole aluminum clamps were substituted (See Figure 8). Additional testing of clamps for large sizes is recommended as a result of MS 21919 and ADEL 479 clamp failures.

The maximum clamping distances for these vibration conditions are listed in Table I.

5. REFERENCES.

The following documents form a part of this report to the extent specified herein:

5.1 Government.

MIL-H-5440D Hydraulic Systems, Aircraft, Types I and II, Design, Installation and Data Requirements For.

MIL-H-5606 Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance.

QQ-S-763C Steel Bars, Shapes, and Forgings, Corrosion - Resisting.

5.2 Society of Automotive Engineers.

AMS 5557A, Steel Tubing, Corrosion and Heat Resistant, 18 Cr - 11Ni - Ti (SAE 30321) Hydraulic.

AMS 5645G, Steel, Corrosion and Heat Resistant, 18 Cr - 10 Ni - Ti (SAE 30321).

TABLE I

SIZE	MAXIMUM ALLOWABLE CLAMPING DISTANCE (MIL-H-5440D) (NO FITTINGS)	MAXIMUM CLAMPING DISTANCE (MIL-H-5440D) (WITH FITTINGS)	MAXIMUM CLAMPING DISTANCE AS DETERMINED FROM SUBJECT TEST		
			UNION SPECIMENS	90° ELBOW SPECIMENS	TEE SPECIMENS
1/4-Inch	16 Inches	12.8 Inches	16 Inches	20 Inches	12 Inches
3/8-Inch	20 Inches	16.0 Inches	16 Inches	23 Inches	16 Inches
1/2-Inch	23 Inches	18.4 Inches	23 Inches	28 Inches	23 Inches
3/4-Inch	27 1/2 Inches	22.0 Inches	28 Inches	28 Inches	28 Inches
1-Inch	30 Inches	24.0 Inches	30 Inches	30 Inches	30 Inches
1 1/4-Inch	31 1/2 Inches	25.2 Inches	32 Inches	32 1/2 Inches	30 Inches
1 1/2-Inch	32 1/2 Inches	26.0 Inches	32 Inches	32 1/2 Inches	28 Inches

5.3 National Aeronautics and Space-Administration.

NASA Contract NAS8-11336 for Evaluation of Mounting Methods and Distances for Aeroquip Brazed Tubing Assemblies.

5.4 American Welding Society.

AWS 25.8 - 62T Brazing Filler Metal Class BAu-4.

5.5 Aeroquip Corporation.

ACES 652 Tubing, Welded and Drawn CRES Steel 321, 1/8 Hard, Hydraulic (Appendix B).

ACES 403 Brazing Procedure and Quality Assurance for Aeroquip Space-Craft Induction Brazing Systems.

6. FACTUAL DATA.

6.1 Description of Test Apparatus.

6.1.1 Radiographic.

The equipment used was a Westinghouse Dynamax, 150 KW, No. HK11A, with a focal spot of 1.0MM. This unit has a sensitivity of 2% and a maximum capacity of 1/2-inch of stainless steel.

6.1.2 Pressure.

The burst pressure equipment used was an Aeroquip designed test stand equipped with a high pressure pump of 10000 psig with an 8:1 ratio intensifier. The pressure gauge has a range of 0 to 30000 psi and an accuracy of $\pm$ 1%. The date of the last calibration was July, 1965. A hand Blackhawk pump was used for pressurization during vibration. The gauge is a 3000 psi gauge with an accuracy of $\pm$ 1%.

6.1.3 Leak Detection.

The equipment used was a Veeco Mass Spectrometer leak detector, Model MS-9AB, which has a detectable leak rate of 2.7×10^{-10} atmos. cc/sec. helium with a negative pressure capability of 1×10^{-6} Torr. The date of the last calibration was July, 1965.

6.1.4 Vibration.

The machine used was an Electrodynamic Vibrator, Ling Model A300 with an ASDE40 (45 channel) automatic random noise rack. The equipment has the following capabilities:

Acceleration, Maximum $\pm$ 100 g's Peak
Amplitude, Maximum: 1.0-inch Peak to Peak
Velocity Limit: 70-inch per second
Axial Suspension Stiffness: 1000 lb. per inch
Exciter Table: 13-1/4-inch diameter - weight 40 lbs.
Slip Table: 30 X 48-inch

	Sinusoidal	Random
Force:	6000 lb. Peak	3200 lb. rms
Frequency Range:	5 to 3000 cps	20 to 2000 cps.
Table Load, Max:	560 lb. at 10 g Peak	280 lb. at 10 g rms
	160 lb. at 30 g Peak	67 lb. at 30 g rms
	80 lb. at 50 g Peak	24 lb. at 50 g rms
	20 lb. at 100 g Peak	10 lb. at 64 g rms

Date of calibration: July, 1965.

7. TEST PROCEDURE.

7.1 Pre-Test Inspection.

The test specimens were inspected to the visual and radiographic requirements of ACES 403.

7.2 Proof Pressure Test.

The 1/4-inch through 1 1/4-inch test specimens were hydrostatically pressurized at 3000 psig and the 1 1/2-inch test specimens at 2250 psig for a period of five (5) minutes.

7.3 Mass Spectrometer Leak Detection Test.

The test specimens were dried in an oven at 225 F for one (1) hour and pressurized with helium to the specified operating pressure. Leakage was checked by use of a mass spectrometer and the leakage rate recorded.

7.4 Test Requirements For Space-Craft Brazed Tubing Assemblies.

Test specimens were subjected to the following series of tests except as noted in the summary:

a) Proof Pressure Test
b) Mass Spectrometer Leak Test
c) Vibration Test
d) Mass Spectrometer Leak Test
e) Burst Test

7.5 Vibration Test.

7.5.1 Testing Set-Up.

The test specimens were tested individually by attaching them to a magnesium test fixture (See Figure 9) with hold-down clamps. The clamping was done in a consistent manner to eliminate as many variables as possible. All tests were conducted using hold-down clamps with stainless steel mesh, butyl rubber or silicone rubber cushioning material. A few aluminum two (2) hole clamps (See Figure 8) were used when the stainless steel clamps failed.

The test specimens were pressurized to 1500 psi with MIL-H-5606 hydraulic fluid during the vibration testing (See Figure 4), using a Blackhawk hand pump with a 3000 psi gauge.

7.5.2 Acceleration Measurement.

The acceleration input control was accomplished by using an accelerometer at the test assembly-test fixture interface (See Figure 4). The output at the center of the specimen was monitored only during the low level sweeps.

7.5.3 Manner of Testing.

7.5.3.1 Resonance Search and Sine Dwell Tests:

The first specimen of each size and configuration was attached to the vibration equipment with a clamping pitch distance (See Figure 5) of four (4) inches. The specimens were oriented so the axis (See Figure 6) of greatest response was excited and were subjected to low level resonance search with output plot of fitting and sine dwell vibration tests, the dwell being for one (1) minute each at the levels specified in Paragraph 7.6.2. Upon completion of this testing the clamping pitch distance was increased in four (4) inch increments up to the maximum allowable in MIL-H-5440D, Paragraph 3.11.28.8 for the same series of tests. The maximum clamping distances for the tubing sizes tested are as follows:

1/4 inch - 16 inches

3/8 inch - 20 inches

1/2 inch - 23 inches

3/4 inch - 27 1/2 inches

1 inch - 30 inches

1 1/4 inch - 31 1/2 inches

1 1/2 inch - 32 1/2 inches

When a specimen failed, a new specimen was installed and a resonance search and dwell at the specified levels was performed at the same clamping distance as before. If the new specimen failed then the third specimen was tested at the next shorter clamping distance. When the specimen did not fail, then the maximum distance was that shown in the Table above or the distance at which the specimen first exhibited a failure.

The test specimens were then subjected to a sinusoidal sweep (logarithmically) 5-2000-5 cps at 1.0 octave/minute at the dwell levels outlined under Paragraph 7.6.2 at the predetermined clamping distance in each of the major specimen axes.

7.5.3.2 Random Vibration.

The test specimens of each size and configuration were vibrated as specified in Paragraph 7.6.3 using hold-down clamps with stainless steel mesh cushions where possible.

7.6 Environmental Tests.

7.6.1 Resonance Search Test Levels.

All test specimens from the 1/4-inch to the 3/4-inch size were vibrated with inputs at the control accelerometers as follows:

5 to 22 cps - 0.075-inch D.A.
22 to 2000 cps - $\pm$2 g (Peak)

All test specimens from the 1-inch to 1 1/2-inch size were vibrated with inputs at the control accelerometers as follows:

5 to 28 cps - 0.075-inch D.A.
28 to 2000 cps - ±3 g (Peak)

7.6.2 Resonance Dwell and Sinusoidal Sweep Test Levels.

The test specimens were vibrated for one (1) minute each at the two (2) major resonances in all three (3) major axes at the following levels:

5 to 32 cps - 0.58-inches D.A.
32 to 76 cps - ±30 g (Peak)
76 to 125 cps - 0.100-inches D.A.
125 to 2000 cps - ±80 g (Peak)

This spectrum was followed to machine capacity.

7.6.3 Random Vibration Test Levels.

After the specimens fulfilled the above sinusoidal levels of testing, they were then vibrated additionally as follows for five (5) minutes in the most severe axis:

20 to 55 cps - 1.5 g^2/cps
55 to 100 cps - +6.0 db/oct.
100 to 1340 cps - 5.0 g^2/cps
1340 to 2000 cps - -9.0 db/oct
2000 cps - 1.5 g^2/cps

This spectrum was split as necessary, but not near a major resonance frequency.

7.7 In-Process Inspection.

Following each phase of the vibration tests the test specimens were visually examined for evidence of damage or deterioration.

7.8 Post-Test Inspection.

Following the vibration tests the test specimens were subjected to visual examination, the proof pressure test as described in Paragraph 7.2 and mass spectrometer leak detection test as described in Paragraph 7.3.

7.9 Burst Test.

The test specimens were pressurized to proof pressure and maintained for five (5) minutes using MIL-H-5606A hydraulic fluid at room temperature. The pressure was slowly increased to 6000 psi for the sizes less than 1 1/2-inches and 3750 psi for the 1 1/2-inch specimens and maintained for five (5) minutes. The pressure was then slowly increased to rupture.

8. TEST RESULTS.

8.1 Pre-Test Inspection.

All test specimens met the visual and radiographic inspection requirements of ACES 403.

8.2 Proof Pressure Test.

All test specimens met the proof pressure test requirements with no leakage or deformation.

8.3 Mass Spectrometer Leak Test.

All test specimens were pressurized to operating pressure with helium and no leakage occurred in the fitting joints.

8.4 Vibration Test.

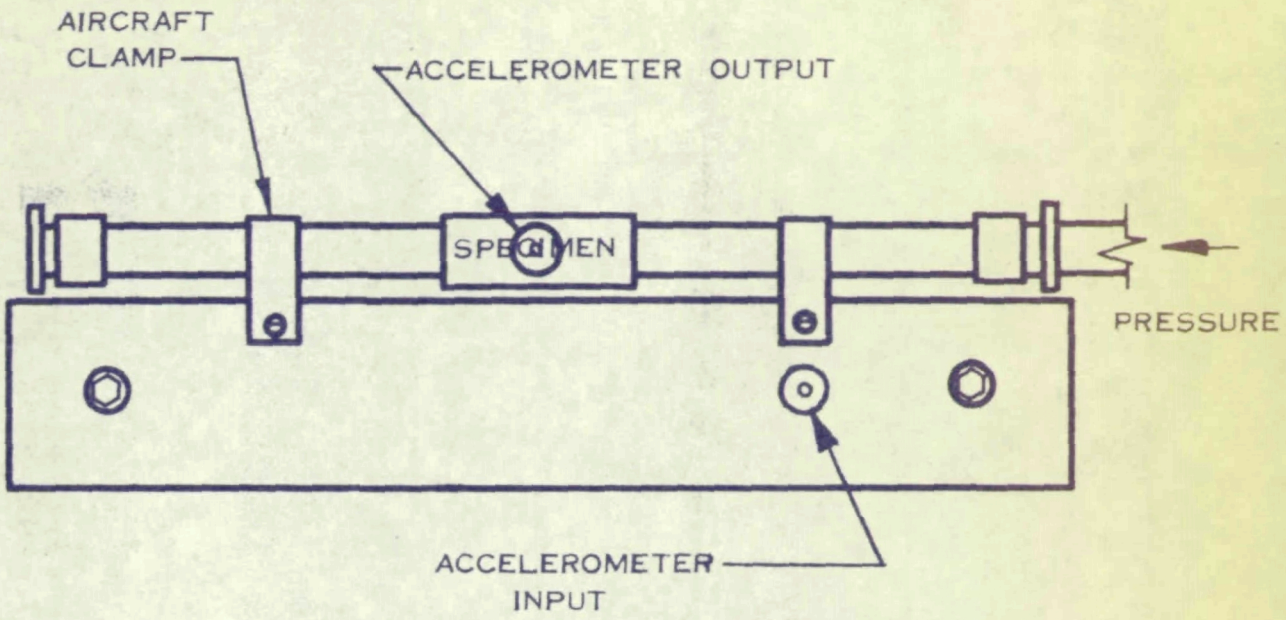
The results of the vibration tests are tabulated on pages 29 through 63. The failure of all clamps occurred during high level resonance dwell or sweeps.

8.5 Post Test Inspection.

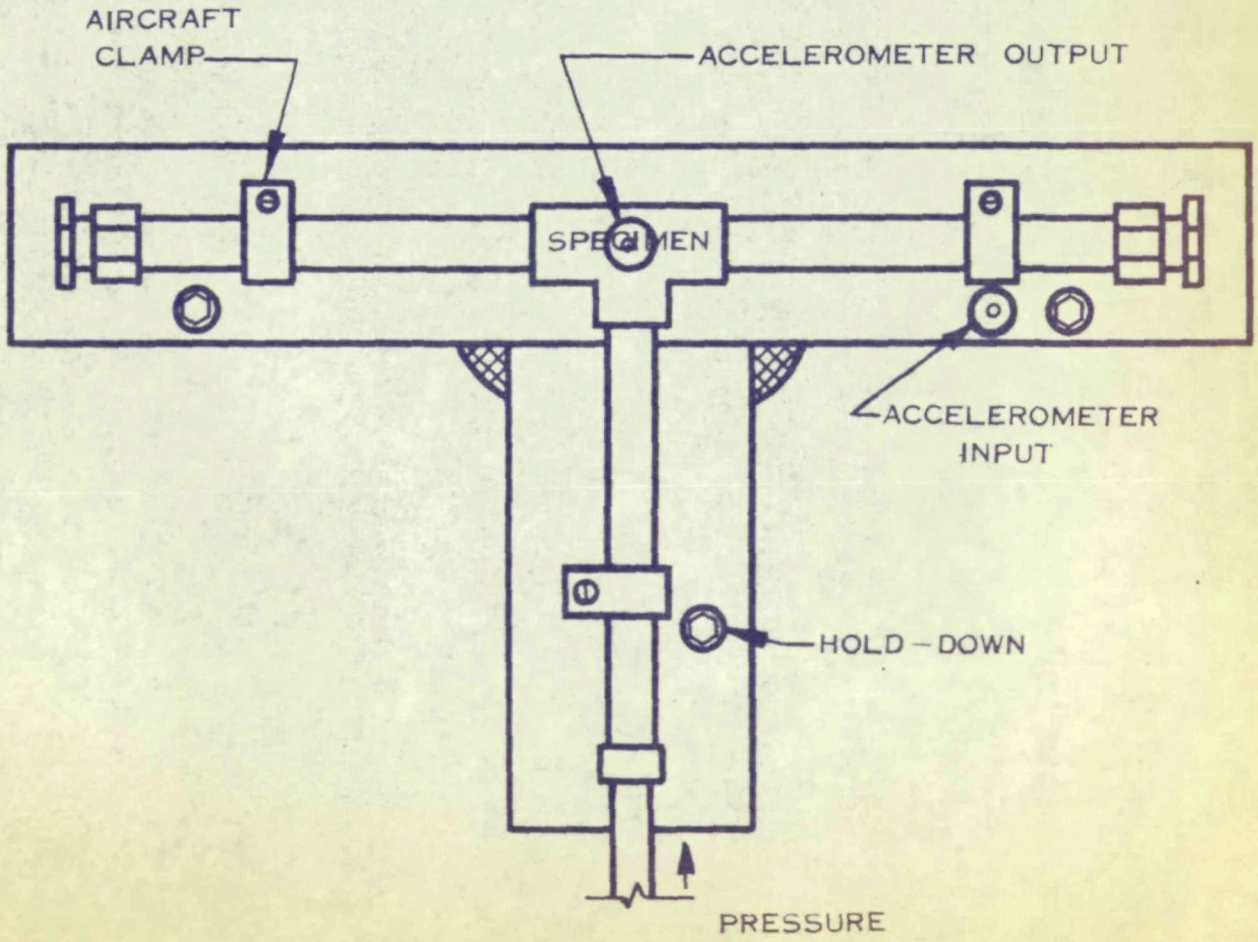
Proof pressure tests and mass spectrometer leak tests of all the specimens which satisfactorily completed the vibration tests revealed that no damage had occurred and no leakage resulted.

8.6 Burst Test.

The results of all burst tests are tabulated in the test summary sheets, Pages 2 through 6.



UNION VIBRATION SET-UP



TEE AND ELBOW VIBRATION SET-UP

FIGURE 4

ENGINEERING STANDARD

No.	ACES 652
PAGE	1 OF 4
APPROVED	A. G. Lusher 2/1/65
ISSUED	25 January 1965
CODE IDENT. NO.	99879

AEROQUIP CORPORATION
AIRCRAFT DIVISION/ELBEECO PLANT
Jackson, Michigan, U.S.A.

CATEGORY **MATERIAL STANDARD**

TITLE

TUBING, WELDED AND DRAWN CRES STEEL 321, 1/8 HARD, HYDRAULIC

REVISION RECORD

PAGE NO.	REVISION LETTER	REVISION DATE	PAGE NO.	REVISION LETTER	REVISION DATE	PAGE NO.	REVISION LETTER	REVISION DATE

DISTR. CODE

Form 92-44 Ray

1. PURPOSE

1.1 This standard was written because there is no known Government specification available for this material.

2. SCOPE

2.1 This specification defines the requirements for a corrosion resistant steel, AISI 321, 1/8 hard welded and drawn aircraft quality hydraulic tubing.

3. APPLICABLE DOCUMENTS

3.1 The following documents, of the issue in effect on the date of the invitation for bids, form a part of this standard to the extent specified herein:

MIL-T-8808	Tubing Steel, Corrosion-Resistant (18-8 Stabilized), Aircraft Hydraulic Quality
FED. STD. NO. 183	Continuous Identification Marking of Iron and Steel Products

4. REQUIREMENTS

4.1 Qualification. The material furnished under this specification shall be a product which has passed the qualification tests specified herein and has been approved by Aeroquip Corporation, Aircraft Division, Elbeeco Plant.

4.2 Product. The tubing shall conform to the provisions of Specification MIL-T-8808 except as follows:

4.2.1 Mechanical Properties. The tubing shall meet the mechanical property requirements of Table I.

TABLE I

MECHANICAL PROPERTIES

NOMINAL O.D (INCHES	NOMINAL WALL THICKNESS (INCHES)	ULTIMATE STRENGTH S. (KSI)	YIELD STRENGTH 0.2% (KSI)	ELONGATION MIN. %
Less than 0.125	All	95 - 130	60 - 90	20
0.125 - 0.188	0.012 - 0.016	95 - 130	60 - 90	25
Over 0.188	All	105 - 140	75 - 110	20

ISSUED25 January 1965 REVISED

4.2.2 Identification of Product. Tubing over 1/4-inch outside diameter shall be marked in accordance with FED-STD-183 to include the following items:

Type:	Welded & Drawn
Composition	321, 1/8 Hard
Heat Number	XXXX
Specification	ACES 652

4.2.3 Pressure Test. The minimum yield strength of Table I shall be used to meet the hydrostatic pressure test of Specification MIL-T-8808.

4.2.4 Tolerances.

4.2.4.1 Outside Diameter. The outside diameter tolerance requirements shall be based on the average of two measurements taken at right angles to each other on the circumference of the tubing and shall be +.003/.000-inch inclusive. The ovality of the tubing shall be within the nominal O.D. tolerance of +.003/.000-inch.

4.2.4.2 Wall Thickness. Wall thickness shall have a tolerance of ±10% of nominal thickness.

4.2.4.3 Length.

4.2.4.3.1 Exact Lengths. Tubing of all sizes may be ordered to exact lengths or in lengths expressed as a multiple of a definite unit, with tolerances as specified in the contract or purchase order.

4.2.4.3.2 Mill Lengths. When exact or multiple lengths are not specified, tubing will be accepted in mill lengths of 5 to 20 feet, but not more than 10% of any order shall be furnished in lengths shorter than 12 feet.

4.2.4.4 Straightness. The maximum curvature as measured from the theoretical center line of the tubing shall not exceed 0.060-inch in a length of 3 feet.

4.2.5 Quality Assurance Provisions.

4.2.5.1 Materials procured to this specification shall meet the quality assurance provisions of Specification MIL-T-8808.

4.2.5.2 Unless otherwise specified, the manufacturer shall submit three test reports to include the results of all tests for chemical analysis and mechanical properties as herein specified.

4.2.6 Preparation for Delivery.

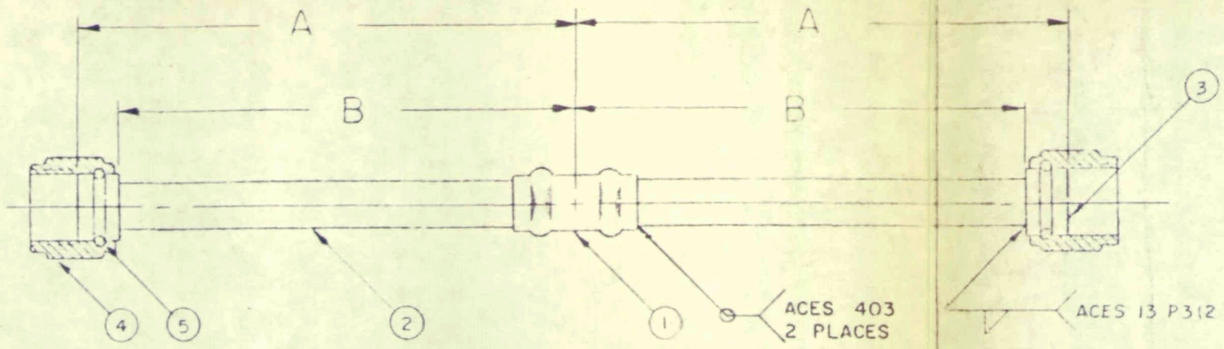
4.2.6.1 Packaging. All material shall be properly separated by size and lot when packaged for shipment, and shall be packed in bundles or boxes of a size and type that will insure safe delivery by common carrier at the lowest rate.

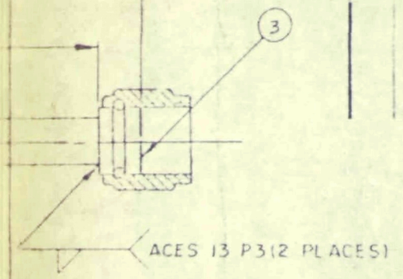
ISSUED 25 January 1965 REVISED

4.2.6.2 Identification. Material containers or packages shall be marked as follows:

MATERIAL:	321 CRES 1/8 HARD
SPECIFICATION:	ACES 652
LOT NO.:	
QUANTITY THIS CONTAINER:	
AEROQUIP PURCHASE ORDER NO.:	

ISSUED 25 January 1965 REVISED





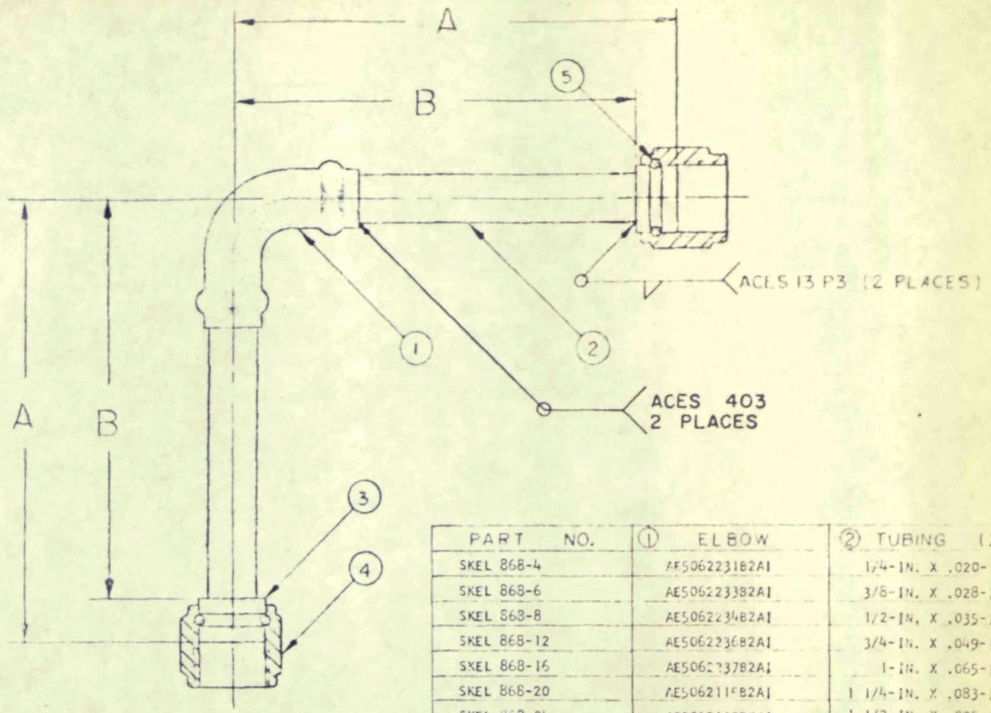
REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL

PART NO.	① UNION	② TUBING (2)	③ SHOULDER (2)	④ NUT (2	⑤ WIRE (2)	"A"	"B"
SKEL 867-4	AE5062201B2A1	1/4-IN. X .020-IN.	900303-4C	029001-4	900303-1-4C	18.34	18.00
SKEL 867-6	AE5062203B2A1	3/8-IN. X .028-IN.	900303-6C	029001-6	900303-1-6C	18.42	18.00
SKEL 867-8	AE5062204B2A1	1/2-IN. X .035-IN.	900303-8C	029001-8	900303-1-8C	18.44	18.00
SKEL 867-12	AE5062206B2A1	3/4-IN. X .049-IN.	900303-12C	029001-12	900303-1-12C	18.53	18.00
SKEL 867-16	AE5062207B2A1	1-IN. X .065-IN.	900303-16C	029001-16	900303-1-16C	18.53	18.00
SKEL 867-20	AE5062114B2A1	11/4-IN. X .083-IN.	900303-20C	029001-20	900303-1-20C	18.59	18.00
SKEL 867-24	AE5062113B2A1	11/2-IN. X .095-IN.	900303-24C	029001-24	900303-1-24C	18.66	18.00

DRAWN	DATE	Aeroquip AEROQUIP CORPORATION
Dr Tornala	12/15/65	
APPROVED	DATE	DRAWING TITLE
RELEASE	DATE	TEST SAMPLE
PROJECT NO.	APC NO.	SPACE-CRAFT UNION
DESIGN APPROVED		CODE IDENT NO. SIZE DRAWING NUMBER
APPROVED		SKEL 867
		SCALE SHEET

FIGURE 1



PART NO.	① ELBOW	② TUBING (2)	③ SHOULDER (2)	④ NUT (2)	⑤ WIRE (2)	"A"	"B"
SKEL 868-4	AE506223182AI	1/4-IN. X .020-IN.	900303-4C	029001-4	900303-1-4C	18.34	18.00
SKEL 868-6	AE506223382AI	3/8-IN. X .028-IN.	900303-6C	029001-6	900303-1-6C	18.42	18.00
SKEL 868-8	AE506223482AI	1/2-IN. X .035-IN.	900303-8C	029001-8	900303-1-8C	18.44	18.00
SKEL 868-12	AE506223682AI	3/4-IN. X .049-IN.	900303-12C	029001-12	900303-1-12C	18.53	18.00
SKEL 868-16	AE506223782AI	1-IN. X .065-IN.	900303-16C	029001-16	900303-1-16C	18.53	18.00
SKEL 868-20	AE506211582AI	1 1/4-IN. X .083-IN.	900303-20C	029001-20	900303-1-20C	18.59	18.00
SKEL 868-24	AE506211982AI	1 1/2-IN. X .095-IN.	900303-24C	029001-24	900303-1-24C	18.66	18.00

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL

P. Donato
P. Tornala 12/12/05

Aeroquip AEROQUIP CORPORATION

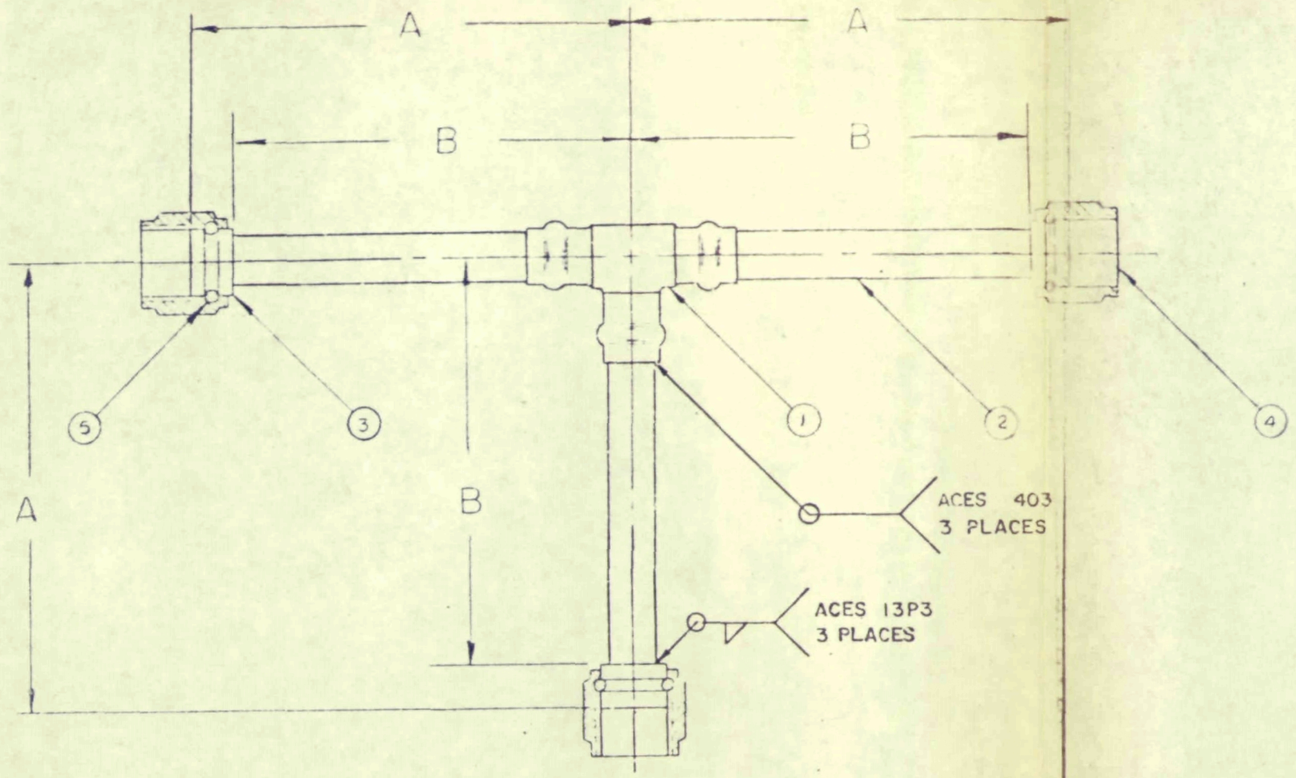
TEST SAMPLE
90° ELBOW

SKEL 868

SCALE NONE

FIGURE 2

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL



PART NO	① TEE	② TUBING (3)	③ SHOULDER (3)	④ NUT (3)	⑤ WIRE (3)	"A"	"B"
SKEL 869-4	AE5062358B2A1	1/4-IN. X .020-IN.	900303-4C	029001-4	900303-1-4C	18.34	18.00
SKEL 869-6	AE5062388B2A1	3/8-IN. X .028-IN.	900303-6C	029001-6	900303-1-6C	18.42	18.00
SKEL 869-8	AE5062401B2A1	1/2-IN. X .035-IN.	900303-8C	029001-8	900303-1-8C	18.44	18.00
SKEL 869-12	AE5062419B2A1	3/4-IN. X .049-IN.	900303-12C	029001-12	900303-1-12C	18.53	18.00
SKEL 869-16	AE5062428B2A1	1-IN. X .065-IN.	900303-16C	029001-16	900303-1-16C	18.53	18.00
SKEL 869-20	AE5062113B2A1	1 1/4-IN. X .083-IN.	900303-20C	029001-20	900303-1-20C	18.59	18.00
SKEL 869-24	AE5062117B7A1	1 1/2-IN. X .095-IN.	900303-24C	029001-24	900303-1-24C	18.66	18.00

DRAWN: Ryan Dantoo
CHECKED: P. Tornala
DATE: 12/13/...
APPROVED
DATE
APPROVED
DATE
RELEASE
DATE
PROJECT NO.
APP. NO.
DESIGN APPROVED
APPROVED

Aeroquip
AEROQUIP CORPORATION
AIRCRAFT DIVISION/ELLICOTT PLANT
Jackson, Michigan U.S.A.

DRAWING TITLE
TEST SAMPLE
SPACE-CRAFT TEE

DOCUMENT NO. 99879 | SIZE | DRAWING NUMBER SKEL 869
SCALE NONE | WT. | STANDARD SHEET | SHEET

FIGURE 3

VIBRATION TEST RESULTS

Aeroquip Corporation

ELBEECO PLANT, JACKSON, MICHIGAN

ENGINEERING DEPARTMENT

SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NF 5-6	SKEL 867-4 (1/4-In. Union)	Transverse (Z)	4 Inches	Resonance Search	5 to 22 cps — 0.075-In. D.A. 22 to 2000 cps — ±2 g (Peak)	RESONANT FREQUENCIES: 391 cps - 12 g OUTPUT 481 cps - 22 g OUTPUT 943 cps - 76 g OUTPUT 1226 cps - 10 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps — 0.58-In. D.A. 32 to 76 cps — ±30 g (Peak) 76 to 125 cps — 0.100-In. D.A. 125 to 2000 cps — ±80 g (Peak)	NO FAILURE at 943 cps - 80 g INPUT NO FAILURE at 481 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 22 cps — 0.075-In. D.A. 22 to 2000 cps — ±2 g (Peak)	RESONANT FREQUENCIES: 304 cps - 52 g OUTPUT 349 cps - 82 g OUTPUT 2024 cps - 50 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps — 0.58-In. D.A. 32 to 76 cps — ±30 g (Peak) 76 to 125 cps — 0.100-In. D.A. 125 to 2000 cps — ±80 g (Peak)	NO FAILURE at 304 cps - 80 g INPUT NO FAILURE at 349 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 22 cps — 0.075-In. D.A. 22 to 2000 cps — ±2 g (Peak)	RESONANT FREQUENCIES: 172 cps - 67 g OUTPUT 184 cps - 34 g OUTPUT 442 cps - 6.4 g OUTPUT 1331 cps - 17.5 g OUTPUT 1654 cps - 5.8 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps — 0.58-In. D.A. 32 to 76 cps — ±30 g (Peak) 76 to 125 cps — 0.100-In. D.A. 125 to 2000 cps — ±80 g (Peak)	NO FAILURE at 172 cps - 80 g INPUT NO FAILURE at 184 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

VIBRATION TEST RESULTS

Aeroquip Corporation
ELBEECO PLANT, JACKSON, MICHIGAN
ENGINEERING DEPARTMENT

SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NF 5-6	SKEL 867-4 1/4-In. Union	Transverse (Z)	16 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES 110 cps - 72 g OUTPUT 117 cps - 28 g OUTPUT 499 cps - 19 g OUTPUT 969 cps - 5.2 g OUTPUT 1868 cps - 5.2 g OUTPUT NO FAILURE	MS 21919 3/4-Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 110 cps - 80 g INPUT NO FAILURE at 117 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(Z)		Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 55 cps - 1.5 g^2/cps RMS 55 to 100 cps - +6.0 db/oct RMS 100 to 150 cps - 5.0 g^2s RMS 150 to 850 cps - +6.0 g^2/cps RMS 850 to 1350 cps - +6.0 g^2/cps RMS 1350 to 2000 cps - -9.0 db/oct RMS 2000 cps - 1.5 g^2/cps RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NH 3-4	SKEL 867-6 3/8-In. Union	Transverse (Z)	4 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 538 cps - 21 g OUTPUT 1403 cps - 56 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 538 cps - 80 g INPUT NO FAILURE at 1403 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 351 cps - 59 g OUTPUT 398 cps - 49 g OUTPUT 483 cps - 43 g OUTPUT 522 cps - 19 g OUTPUT 888 cps - 20.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

VIBRATION TEST RESULTS

Aeroquip Corporation

ELBEECO PLANT, JACKSON, MICHIGAN
ENGINEERING DEPARTMENT

SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NH 3-4	SKEL 867-6 3/8-In. Union	Transverse (Z)	8 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 351 cps - 80 g INPUT NO FAILURE at 398 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ± 2 g (Peak)	RESONANT FREQUENCIES: 237 cps - 24 g OUTPUT 277 cps - 30 g OUTPUT 398 cps - 30 g OUTPUT 584 cps - 21.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 277 cps - 80 g INPUT NO FAILURE at 584 cps - 80 g INPUT	MS 219193/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			16 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 146 cps - 38 g OUTPUT 172 cps - 46 g OUTPUT 451 cps - 14.5 g OUTPUT 1269 cps - 28 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 146 cps - 80 g INPUT NO FAILURE at 172 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			20 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ± 2 g (Peak)	RESONANT FREQUENCIES: 118 cps - 65 g OUTPUT 127 cps - 57 g OUTPUT 759 cps - 10.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

VIBRATION TEST RESULTS

Aeroquip Corporation

ELBEECO PLANT, JACKSON, MICHIGAN
ENGINEERING DEPARTMENT

SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS		VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NH 3-4	SKEL 867-6 3/8-In. Union	Transverse (Z)	20 Inches	Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) - 0.100-In. D.A. - ±80 g (Peak)	Run Tubing (NH4 Leg) Failed Adjacent To The Fitting At 127 cps - 80 g	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NH 5-6	SKEL 867-6 3/8-In. Union	Transverse (Z)	20 Inches	Resonance Search	5 to 22 cps 22 to 2000 cps	0.075-In. D.A. - ±2 g (Peak)	RESONANT FREQUENCIES: 119 cps - 78 g OUTPUT 126 cps - 43 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) - 0.100-In. D.A. - ±80 g (Peak)	Run Tubing (NH6 Leg) Failed Adjacent To The Fitting At 126 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NH 1-2	SKEL 867-6 3/8-In. Union	Transverse (Z)	16 Inches	Resonance Search	5 to 22 cps 22 to 2000 cps	0.075-In. D.A. - ±2 g (Peak)	RESONANT FREQUENCIES: 148 cps - 20.5 g OUTPUT 176 cps - 19.5 g OUTPUT 1134 cps - 17 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) - 0.100-In. D.A. - ±80 g (Peak)	NO FAILURE at 148 cps - 80 g INPUT NO FAILURE at 176 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) - 0.100-In. D.A. - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NH 1-2	SKEL 867-6 3/8-In. Union	Transverse (Z)	16 Inches	Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 56 cps - 1.5 g^2/cps RMS 56 to 70 cps - 3.0 g^2/cps RMS 70 to 100 cps - 6.0 g^2/cps RMS 100 to 800 cps - 5.0 g^2/cps RMS 800 to 1250 cps - 5.0 g^2/cps RMS 1250 to 1350 cps - 5.0 g^2/cps RMS 1350 to 2000 cps - -9.0 db/oct RMS 2000 to 2050 cps - 1.5 g^2/cps RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NJ 5-6	SKEL 867-8 1/2-In. Union	Transverse (Z)	4 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 350 cps - 25 g OUTPUT 1648 cps - 18 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 350 cps - 80 g INPUT NO FAILURE at 1648 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 194 cps - 8 g OUTPUT 340 cps - 7 g OUTPUT 642 cps - 27.5 OUTPUT 1088 cps - 5.6 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 194 cps - 80 g INPUT NO FAILURE at 642 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 165 cps - 8.6 g OUTPUT 289 cps - 13.5 g OUTPUT 353 cps - 140 g OUTPUT 429 cps - 19 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS		VIBRATION TEST RESULTS		CLAMP USED AND RESULT
NJ 5-6	SKEL 867-8 1/2-In. Union	Transverse (Z)	12 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)		NO FAILURE at 289 cps - 80 g NO FAILURE at 353 cps - 80 g	INPUT INPUT	MS 219193/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			16 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)		RESONANT FREQUENCIES: 161 cps - 18 g OUTPUT 217 cps - 25 g OUTPUT 1576 cps - 20 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)		NO FAILURE AT 161 cps - 80 g NO FAILURE at 217 cps - 80 g	INPUT INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			20 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)		RESONANT FREQUENCIES: 47 cps - 4.5 g OUTPUT 55 cps - 4.6 g OUTPUT 135 cps - 35 g OUTPUT 159 cps - 53 g OUTPUT 913 cps - 9 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)		NO FAILURE at 47 cps - 30 g NO FAILURE at 159 cps - 80 g	INPUT INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion. 3 Clamps Failed - Replaced With Butyl Rubber Cushion Clamp - No Failure
			23 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)		RESONANT FREQUENCIES: 41 cps - 3.8 g OUTPUT 44 cps - 6 g OUTPUT 117 cps - 32 g OUTPUT 129 cps - 50 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NJ 5-6	SKEL 867-8 1/2-in. Union	Transverse (Z)	23 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE At 44 cps - 30 g INPUT NO FAILURE at 129 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - 16.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 56 cps - 1.5 g^2/cps RMS 56 to 70 cps - 3.0 g^2/cps RMS 70 to 100 cps - 6.0 g^2/cps RMS 100 to 800 cps - 5.0 g^2/cps RMS 800 to 1300 cps - 5.0 g^2/cps RMS 1300 to 2000 cps - -9.0 db/oct RMS 2000 to 2050 cps - 1.5 g^2/cps RMS NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
NL 3-4	SKEL 867-12 3/4-in. Union	Transverse (Z)	4 Inches	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 151 cps - 2.8 g OUTPUT 251 cps - 3.7 g OUTPUT 825 cps - 11 g OUTPUT 1623 cps 14 g NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 151 cps - 80 g INPUT NO FAILURE at 251 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 214 cps - 5.2 g OUTPUT 649 cps - 24.5 g OUTPUT 944 cps - 8 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NL 3-4	SKEL 867-12 3/4-In. Union	Transverse (Z)	8 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 649 cps - 80 g INPUT NO FAILURE at 944 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 149 cps - 10.5 g OUTPUT 439 cps - 78 g OUTPUT 1313 cps - 9.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 149 cps - 80 g INPUT NO FAILURE at 439 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			16 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 141 cps - 10 g OUTPUT 279 cps - 32 g OUTPUT 1793 cps - 12 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 279 cps - 80 g INPUT NO FAILURE at 1793 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			20 Inches	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 141 cps - 14 g OUTPUT 218 cps - 33 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NL 3-4	SKEL 867-12 3/4-in. Union	Transverse (Z)	20 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	141 cps - 80 g INPUT 218 cps - 80 g INPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
			24 Inches	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 112 cps - 11 g OUTPUT 293 cps - 6 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 112 cps - 0.100-in. D.A. INPUT NO FAILURE at 293 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion. 5 Clamps Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
			28 Inches	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 79 cps - 6.7 g OUTPUT 111 cps - 7.1 g OUTPUT 283 cps - 7.1 g OUTPUT 753 cps - 12 g OUTPUT 1449 cps - 6.1 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 111 cps - 0.100-in. D.A. INPUT NO FAILURE at 283 cps - 80 g INPUT NO FAILURE at 753 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion. 1 Clamp Failed
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion. 3 Clamps Failed

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NL 3-4	SKEL 867-12 3/4-In. Union	Transverse (Z)	28 Inches	Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - 14 g^2 100 to 150 cps - 5.0 g^2/cps - 16 g RMS 150 to 400 cps - 5.0 g^2/cps - 35 g RMS 400 to 650 cps - 5.0 g^2/cps - 35 g RMS 650 to 900 cps - 5.0 g^2/cps - 35 g RMS 900 to 1150 cps - 5.0 g^2/cps - 35 g RMS 1150 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - 9.0 db/oct - 25 g RMS 1700 to 2000 cps - 9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 3 Clamps Failed - Replaced With Silicone Cushion No Clamp Failure
NM 1-2	SKEL 867-16 1-In. Union	Transverse (Z)	4 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 152 cps - 12 g OUTPUT 285 cps - 17 g OUTPUT 746 cps - 40 g OUTPUT 1199 cps - 11 g OUTPUT 1613 cps - 17.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 152 cps - 80 g INPUT NO FAILURE at 746 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 145 cps - 10 g OUTPUT 319 cps - 25 g OUTPUT 345 cps - 48 g OUTPUT 635 cps - 22 g OUTPUT 1710 cps - 12.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 145 cps - 80 g INPUT NO FAILURE at 345 cps - 80 g INPUT	MS 21919 3/4-In. Wide - CRES Mesh Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 138 cps - 7.6 g OUTPUT 332 cps - 48 g OUTPUT 1729 cps - 22 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULTS
NM 1-2	SKEL 867-16 1-in. Union	Transverse (Z)	12 Inches	Sinusoidal Dwell	5 to 32 cps – 0.58-in. D.A. 32 to 76 cps – ±30 g (Peak) 76 to 125 cps – 0.100-in. D.A. 125 to 2000 cps – ±80 g (Peak)	NO FAILURE at 138 cps - 80 g INPUT NO FAILURE at 332 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion. 3 Clamps Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
			16 Inches	Resonance Search	5 to 28 cps – 0.075-in. D.A. 28 to 2000 cps – ±3 g (Peak)	RESONANT FREQUENCIES: 149 cps - 16 g OUTPUT 299 cps - 50 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps – 0.58-in. D.A. 32 to 76 cps – ±30 g (Peak) 76 to 125 cps – 0.100-in. D.A. 125 to 2000 cps – ±80 g (Peak)	NO FAILURE at 149 cps - 80 g INPUT NO FAILURE at 299 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion. 1 Clamp Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
			20 Inches	Resonance Search	5 to 28 cps – 0.075-in. D.A. 28 to 2000 cps – ±3 g (Peak)	RESONANT FREQUENCIES: 126 cps - 6.6 g OUTPUT 138 cps - 6.6 g OUTPUT 238 cps - 11 g OUTPUT 316 cps - 28 g OUTPUT 487 cps - 9 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion. No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps – 0.58-in. D.A. 32 to 76 cps – ±30 g (Peak) 76 to 125 cps – 0.100-in. D.A. 125 to 2000 cps – ±80 g (Peak)	NO FAILURE at 238 cps - 80 g INPUT NO FAILURE at 316 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			24 Inches	Resonance Search	5 to 28 cps – 0.075-in. D.A. 28 to 2000 cps – ±3 g (Peak)	RESONANT FREQUENCIES: 91 cps - 19 g OUTPUT 238 cps - 31 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NM 1-2	SKEL 867-16 1-in. Union	Transverse (Z)	24 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 91 cps - 0.100-in. D.A. INPUT NO FAILURE at 238 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			28 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 98 cps - 12 g OUTPUT 274 cps - 38 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 98 cps - 0.100-in. D.A. INPUT NO FAILURE at 274 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			30 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 86 cps - 10.5 g OUTPUT 126 cps - 10 g OUTPUT 297 cps - 28 g OUTPUT 788 cps - 13.5 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 86 cps - 0.100-in. D.A. INPUT NO FAILURE at 297 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion. Excessive Heat Buildup In Butyl Rubber Cushion No Clamp Failure
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE.	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion. 2 Clamps Failed - Replaced With Solid Alum 2 Hole Clamp No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS		CLAMP USED AND RESULT
NM 1-2	SKEL 867-16 1-in. Union	Transverse (Z)	30 Inches	Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - .5 g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NN 1-2	SKEL 867-20 11/4-In. Union	Transverse (Z)	4 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 128 cps - 16 g OUTPUT 214 cps - 10.5 g OUTPUT 771 cps - 37 g OUTPUT 816 cps - 26 g OUTPUT 1740 cps - 14.5 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 128 cps - 80 g NO FAILURE at 771 cps - 80 g	INPUT INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 109 cps - 17.5 g OUTPUT 200 cps - 11.5 g OUTPUT 615 cps - 21.5 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 109 cps - 80 g NO FAILURE at 615 cps - 80 g	INPUT INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 101 cps - 23.5 g OUTPUT 210 cps - 7.5 g OUTPUT 540 cps - 7.3 g OUTPUT 1701 cps - 9.6 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS		VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NN 1-2	SKEL 867-20 11/4-In. Union	Transverse (Z)	12 Inches	Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) 0.100-In. D.A. ±80 g (Peak)	NO FAILURE at 101 cps - 0.100-In. D.A. INPUT NO FAILURE at 210 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			16 Inches	Resonance Search	5 to 28 cps 28 to 2000 cps	0.075-In. D.A. ±3 g (Peak)	RESONANT FREQUENCIES: 80 cps - 12.5 g OUTPUT 179 cps - 8.5 g OUTPUT 328 cps - 22.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cp 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) 0.100-In. D.A. ±80 g (Peak)	NO FAILURE at 80 cps - 0.100-In. D.A. INPUT NO FAILURE at 328 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			20 Inches	Resonance Search	5 to 28 cps 28 to 2000 cps	0.075-In. D.A. ±3 g (Peak)	RESONANT FREQUENCIES: 67 cps - 16 g OUTPUT 267 cps - 28 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) 0.100-In. D.A. ±80 g (Peak)	NO FAILURE at 67 cps - 0.100-In. D.A. INPUT NO FAILURE at 267 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			24 Inches	Resonance Search	5 to 28 cps 28 to 2000 cps	0.075-In. D.A. ±3 g (Peak)	RESONANT FREQUENCIES: 62 cps - 14 g OUTPUT 277 cps - 15 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NN 1-2	SKEL 867-20 11/4-In. Union	Transverse (Z)	24 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 62 cps - 30 g INPUT NO FAILURE at 277 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 4 Clamps Failed - Replace With New Clamps
			28 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 69 cps - 17 g OUTPUT 291 cps - 16 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 1 Clamp Failed - Replaced With New Clamp
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 69 cps - 30 g INPUT NO FAILURE at 291 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion Failed 1 Clamp
			32 Inches	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 93 cps - 32 g OUTPUT 305 cps - 14 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 93 cps - 0.100-In. D.A. INPUT NO FAILURE at 305 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 1 Clamp Failed At Clamp Hold-down Bolt
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919-20 CRES - Butyl Rubber Cushion. 7 Clamps Failed - Replaced With Silicon Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NN 1-2	SKEL 867-20 11/4-in. Union	Transverse (Z)	32 Inches	Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - 9.0 db/oct - 25 g RMS NO FAILURE	MS 21919-20 CRES - Butyl Rubber Cushion. 7 Clamps Failed - Replaced With Solid Alum. 2 Hole Clamps No Clamp Failure
NP 1-2	SKEL 867-24 11/2-in. Union	Transverse (Z)	4 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 98 cps - 7.5 g OUTPUT 203 cps - 9.5 g OUTPUT 707 cps - 20 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 203 cps - 80 g INPUT NO FAILURE at 707 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			8 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 99 cps - 9.5 g OUTPUT 217 cps - 15 g OUTPUT 618 cps - 11.5 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 99 cps - 0.100-in. D.A. 52 g INPUT NO FAILURE at 217 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			12 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 86 cps - 19 g OUTPUT 318 cps - 35 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NP 1-2	SKEL 867-24 11/2-in. Union	Transverse (X)	12 Inches	Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 86 cps - 0.100-in. D.A. 37 g INPUT NO FAILURE at 318 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			16 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 67 cps - 19 g OUTPUT 281 cps - 30 g OUTPUT 523 cps - 11.5 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 67 cps - 30 g INPUT NO FAILURE at 281 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			20 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 57 cps - 14 g OUTPUT 157 cps - 12 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 57 cps - 30 g INPUT NO FAILURE at 157 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			24 Inches	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 41 cps - 17 g OUTPUT 121 cps - 25 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS		VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NP 1-2	SKEL 867-24 1 1/2-In. Union	Transverse (Z)	24 Inches	Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) 0.100-In. D.A. ±80 g (Peak)	41 cps - 30 g INPUT 121 cps - 0.100-In. D.A. 72-g INPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			28 Inches	Resonance Search	5 to 28 cps 28 to 2000 cps	0.075-In. D.A. ±3 g (Peak)	RESONANT FREQUENCIES: 40 cps - 16 g OUTPUT 61 cps - 12.5 g OUTPUT 125 cps - 14 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) 0.100-In. D.A. ±80 g (Peak)	NO FAILURE at 40 cps - 30 g INPUT NO FAILURE at 125 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			32 Inches	Resonance Search	5 to 28 cps 28 to 2000 cps	0.075-In. D.A. ±3 g (Peak)	RESONANT FREQUENCIES: 36 cps - 13 g OUTPUT 62 cps - 11 g OUTPUT 124 cps - 19.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) 0.100-In. D.A. ±80 g (Peak)	NO FAILURE at 36 cps - 30 g INPUT NO FAILURE at 124 cps - 0.100-In. D.A. 79 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
		(Z) & (X)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min			NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 5 Clamps Failed. Replaced With ADEL 479 Clamp. Failed. Replaced With Solid Alum. 2 Hole Clamp. No Clamp Failure.

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NP 1-2	SKEL 867-24 1 1/2-In. Union	Transverse (Z)	32 Inches	Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 219193/4-In. Wide CRES - Butyl Rubber Cushion. 2 Clamps Failed - Replaced With ADEL 479 Clamp. Failed. Replaced With Solid Alum 2 Hole Clamp. No Clamp Failure.
NF 7-8	SKEL 868-4 1/4-In. Elbow	(Z)	6 Inches From Center Line of Fitting (See Fig. 5)	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 82 cps - 54 g OUTPUT 562 cps - 13.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 82 cps - 0.100-In. D.A. INPUT NO FAILURE at 562 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			10 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 39 cps - 23 g OUTPUT 323 cps - 16 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 39 cps - 30 g INPUT NO FAILURE at 323 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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NF 7-8	SKEL 868-4 1/4-In. Elbow	(Z)	10 Inches From Center Line of Fitting	Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - 6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1 g^2/cps	20 to 100 cps - 14 g - Failed One (1) Clamp 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE		MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion. 1 Clamp Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
		(Y)	10 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 1000 cps - ±80 g (Peak)	NO FAILURE		MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NH 7-8	SKEL 868-6 3/8-In. Elbow	(Z)	6 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 50 cps - 3.2 g OUTPUT 145 cps - 36 g OUTPUT 946 cps - 4.2 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 50 cps - 30 g NO FAILURE at 145 cps - 80 g	NPUT NPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
			10 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.58-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 64 cps - 42 g OUTPUT 561 cps - 5.4 g OUTPUT NO FAILURE		MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 64 cps - 30 g NO FAILURE at 561 cps - 80 g	NPUT NPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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NH 7-8	SKEL 868-6 3/8-In. Elbow	(Z)	10 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
		(Y)	8 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NJ 7-8	SKEL 868-8 1/2-In. Elbow	(Z)	8 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 45 cps - 4.5 g OUTPUT 131 cps - 50 g OUTPUT 181 cps - 9.5 g OUTPUT 203 cps - 9.5 g OUTPUT 1044 cps - 9.5 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 45 cps - 30 g INPUT NO FAILURE at 131 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
			11.5 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 38 cps - 4.2 g OUTPUT 73 cps - 42 g OUTPUT 526 cps - 28 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NJ 7-8	SKEL 868-8 1/2-in. Elbow	(Z)	11.5 Inches From Center Line of Fitting	Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 38 cps - 30 g INPUT NO FAILURE at 73 cps - 30 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - 6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion. 1 Clamp Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
		(Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NL 20-21	SKEL 868-12 3/4-in. Elbow	(Z)	10 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 101 cps - 21 g OUTPUT 186 cps - 5.7 g OUTPUT 807 cps - 6.8 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 101 cps - 0.100-in. D.A. INPUT NO FAILURE at 186 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NL 20-21	SKEL 868-12 3/4-in. Elbow	(Z)	14 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 48 cps - 10 g OUTPUT 191 cps - 5.5 g OUTPUT 526 cps - 10 g OUTPUT 594 cps - 22 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 48 cps - 30 g INPUT NO FAILURE at 594 cps - 80 g INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
NM 18-19	SKEL 868-16 1-in. Elbow	(Z)	15 Inches From Center Line of Fitting	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 102 cps - 70 g OUTPUT 433 cps - 18 g OUTPUT 631 cps - 110 g OUTPUT 697 cps - 46 g OUTPUT 1781 cps - 56 g OUTPUT NO FAILURE	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NM 18-19	SKEL 868-16 1-In. Elbow	(Z)	15 Inches From Center Line of Fitting	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 102 cps - 0.100-In. D.A. INPUT NO FAILURE at 1781 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 t 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 56 cps - 1.5 g^2/cps 14 g RMS 56 to 100 cps - +9.0 db/oct 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion. 2 Clamps Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
		(Y)		Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 480 cps - 16 g OUTPUT 678 cps - 16 g OUTPUT 1197 cps - 22 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 480 cps - 80 g INPUT NO FAILURE at 1197 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NN 16-17	SKEL 868-20 11/4-In. Elbow	(Z)	161/4 inches From Center Line of Fitting	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 111 cps - 105 g OUTPUT 329 cps - 19 g OUTPUT 620 cps - 39 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 111 cps - 0.100-In. D.A. - 63 g INPUT NO FAILURE At 620 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 G (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion. 4 Clamps Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - +6.0 db/oct 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
		(Y)		Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 492 cps - 29 g OUTPUT 704 cps - 25 g OUTPUT 971 cps - 30 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE AT 492 cps - 80 g INPUT NO FAILURE At 971 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS		CLAMP USED AND RESULT
NP 18-19	SKEL 868-24 11/2-in. Elbow	(Z)	161/4 Inches From Center Line of Fitting	Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 75 cps - 23 g OUTPUT 264 cps - 34 g OUTPUT 842 cps - 40 g OUTPUT NO FAILURE		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 75 cps - 30 g NO FAILURE at 842 cps - 80 g	INPUT INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - +9.00 db/oct - 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(Y)		Resonance Search	5 to 28 cps - 0.075-in. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 172 cps - 10.5 g OUTPUT 218 cps - 10.5 g OUTPUT 419 cps - 5 g 986 cps - 11.5 g NO FAILURE		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 172 cps - 80 g NO FAILURE at 986 cps - 80 g	INPUT INPUT	MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NP 18-19	SKEL 868-24 11/2-In. Elbow	(Y)	161/4 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NF 19-20-21	SKEL 869-4 1/4-In. Tee	(Z)	8 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 35 cps - 5.2 g OUTPUT 100 cps - 50 g OUTPUT 500 cps - 57 g OUTPUT 844 cps - 33 g OUTPUT 1900 cps - 55 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 100 cps - 0.100-In. D.A. INPUT NO FAILURE at 1900 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	Test Specimen End Fitting Broke Off During Down Cycle At Approximately 125 cps.	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NF 16-17-18	SKEL 869-4 1/4-In. Tee	(Z)	8 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 36 cps - 3.5 g OUTPUT 103 cps - 45 g OUTPUT 502 cps - 12 g OUTPUT 1905 cps - 30 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 126 cps - 80 g INPUT NO FAILURE at 1905 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NF 16-17-18	SKEL 869-4 1/4-In. Tee	(Z)	8 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	Tubing Failed At Edge Of Fitting, NF18 Leg During Down Cycle At Approximately 100 cps	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
NF 13-14-15	SKEL 869-4 1/4-In. Tee	(Z)	6 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 165 cps - 42 g OUTPUT 1824 cps - 26 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE At 165 cps - 80 g INPUT NO FAILURE At 1824 cps 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps -35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
		(X) & (Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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NH 19-20-21	SKEL 869-6 3/8-In. Tee	(Z)	10 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps 22 to 2000 cps	0.075-In. D.A. - ±2 g (Peak)	RESONANT FREQUENCIES: 113 cps - 63 g OUTPUT 729 cps - 32 g OUTPUT 777 cps - 35 g OUTPUT 1911 cps - 72 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) - 0.100-In. D.A. - ±80 g (Peak)	NO FAILURE at 113 cps - 0.100-Inch D.A. INPUT NO FAILURE at 1911 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps 55 to 100 cps 100 to 1340 cps 1340 to 2000 cps 2000 cps - 1.5 g^2/cps	1.5 g^2/cps +6.0 db/oct - 5.0 g^2/cps - -9.0 db/oct	20 to 100 cps - +9.0 db/oct - 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion. 1 Clamp Failed - Replaced With Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 (Peak) - 0.100-In. D.A. - ±80 g (Peak)	Tube Failed At Edge of Fitting, NH20 Leg, At 125 cps - 80 g OUTPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NH 16-17-18	SKEL 869-6 3/8-In. Tee	(Z)	10 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps 22 to 2000 cps	0.075-In. D.A. - ±2 g (Peak)	RESONANT FREQUENCIES: 38 cps - 6.3 g OUTPUT 112 cps - 78 g OUTPUT 725 cps - 46 g OUTPUT 790 cps - 16 g OUTPUT 1817 cps - 29 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps 32 to 76 cps 76 to 125 cps 125 to 2000 cps	0.58-In. D.A. ±30 g (Peak) - 0.100-In. D.A. - ±80 g (Peak)	NO FAILURE at 112 cps - 0.100-Inch D.A. INPUT Tubing Failed at Edge Of Fitting, NH18 Leg, At 725 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NH 13-14-15	SKEL 869-6 3/8-In. Tee	(Z)	8 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 152 cps - 78 g OUTPUT 531 cps - 17 g OUTPUT 691 cps - 46 g OUTPUT 854 cps - 9.2 g OUTPUT 1175 cps - 6 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 22 cps - 0.58-In. D.A. 22 to 76 cps - ±30 g (PEAK) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE At 152 cps - 80 g INPUT NO FAILURE At 691 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 3 Clamps Failed - Replaced With New Clamp No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 2 Clamps Failed - Replaced With New Clamp No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1. g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps -35 g RMS 850 to 1100 cps - 5.0 g^2/cps -35 g RMS 1100 to 1350 cps - 5.0 g^2/cps -35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
		(X) & (Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NJ 16-17-18	SKEL 869-8 1/2-In. Tee	(Z)	11.5 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 37 cps - 5 g OUTPUT 107 cps - 52 g OUTPUT 597 cps - 9.5 g OUTPUT 1926 cps - 17 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - CRES Mesh Cushion No Clamp Failure

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VIBRATION TEST RESULTS

SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS		CLAMP USED AND RESULT
NJ 16-17-18	SKEL 869-8 1/2-in. Tee	(Z)	11.5 Inches From Center Line of Fitting	Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 37 cps - 30 g INPUT NO FAILURE at 107 cps - 0.100-in. D.A. - INPUT		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - +9.0 db/oct - 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE Of Test Specimen		MS 21919 3/4-in. Wide CRES - CRES Mesh Cushion. 2 Clamps Failed - Replaced With New Clamps No Clamp Failure
		(X) & (Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE		MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NL 10-11-12	SKEL 869-12 3/4-in. Tee	(Z)	10 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-in. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 204 cps - 26 g OUTPUT 279 cps - 5 g OUTPUT 1285 cps - 6.6 g OUTPUT NO FAILURE		MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-in. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-in. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 204 cps - 80 g INPUT NO FAILURE at 1285 cps - 80 g INPUT		MS 21919 3/4-in. Wide CRES - Butyl Rubber Cushion No Clamp Failure

VIBRATION TEST RESULTS

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NL 10-11-12	SKEL 869-12 3/4-In. Tee	(Z)	14 Inches From Center Line of Fitting	Resonance Search	5 to 22 cps - 0.075-In. D.A. 22 to 2000 cps - ±2 g (Peak)	RESONANT FREQUENCIES: 97 cps - 14 g OUTPUT 637 cps - 48 g OUTPUT 1852 cps - 60 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100 In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 97 cps - 0.100-In. D.A. INPUT NO FAILURE at 637 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - 14 g 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
		(X) & (Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NM 10-11-12	SKEL 869-16 1-In. Tee	(Z)	15 Inches From Center Line of Fitting	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 94 cps - 21 g OUTPUT 769 cps - 32 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

VIBRATION TEST RESULTS

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NM 10-11-12	SKEL 869-16 1-In. Tee	(Z)	15 Inches From Center Line of Fitting	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE At 94 cps - 0.100-In. D.A. - INPUT NO FAILURE at 769 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 4 Clamps Failed - Replaced With New Clamps No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 1000cps - +9.0 db/oct - 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 2 Clamps Failed - Replaced With Silicon Cushion No Clamp Failure
		(X) & (Y)		Sinusoidal Sweep	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 2 Clamps Failed - Replaced With Silicone Cushion No Clamp Failure
NN 10-11-12	SKEL 869-20 11/4-In. Tee	(Z)	15 Inches From Center Line of Fitting	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 90 cps - 28 g OUTPUT 742 cps - 22 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE at 90 cps - 0.100-In. D.A. INPUT NO FAILURE at 742 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 1 Clamp Failed - Replaced With Silicone Cushion No Clamp Failure

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SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS	VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NN 10-11-12	SKEL 869-20 11/4-In. Tee	(Z)	15 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min		NO FAILURE	MS 21919 3/4-In. Wide CRES - Silicone Cushion - Replaced With Solid Alum 2 Hole Clamps No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - +6.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps	20 to 100 cps - +9.0 db/oct - 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Silicone Cushion - Replaced With Solid Alum 2 Hole Clamps No Clamp Failure
		(X) & (Y)	16 Inches From Center Line of Fitting	Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	NO FAILURE	MS 21919 3/4-In. Wide CRES - Silicone Cushion. 2 Clamps Failed - Replaced with Solid Alum. 2 Hole Clamps No Clamp Failure
NP 7-8-9	SKEL 869-24 11/2-In. Tee	(Z)	16 1/2 Inches From Center Line of Fitting	Resonance Search	5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 G (Peak)	RESONANT FREQUENCIES: 88 cps - 50 g OUTPUT 755 cps - 75 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
				Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)	88 cps - 0.100-In. D.A. INPUT Tubing Failed At Edge of Fitting NP8 Leg	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure
NP 10-11-12	SKEL 869-24 11/2-In. Tee	(Z)	14 Inches From Center Line of Fitting		5 to 28 cps - 0.075-In. D.A. 28 to 2000 cps - ±3 g (Peak)	RESONANT FREQUENCIES: 161 cps - 21 g OUTPUT 183 cps - 16 g OUTPUT 278 cps - 25 g OUTPUT 346 cps - 12 g OUTPUT NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion No Clamp Failure

VIBRATION TEST RESULTS

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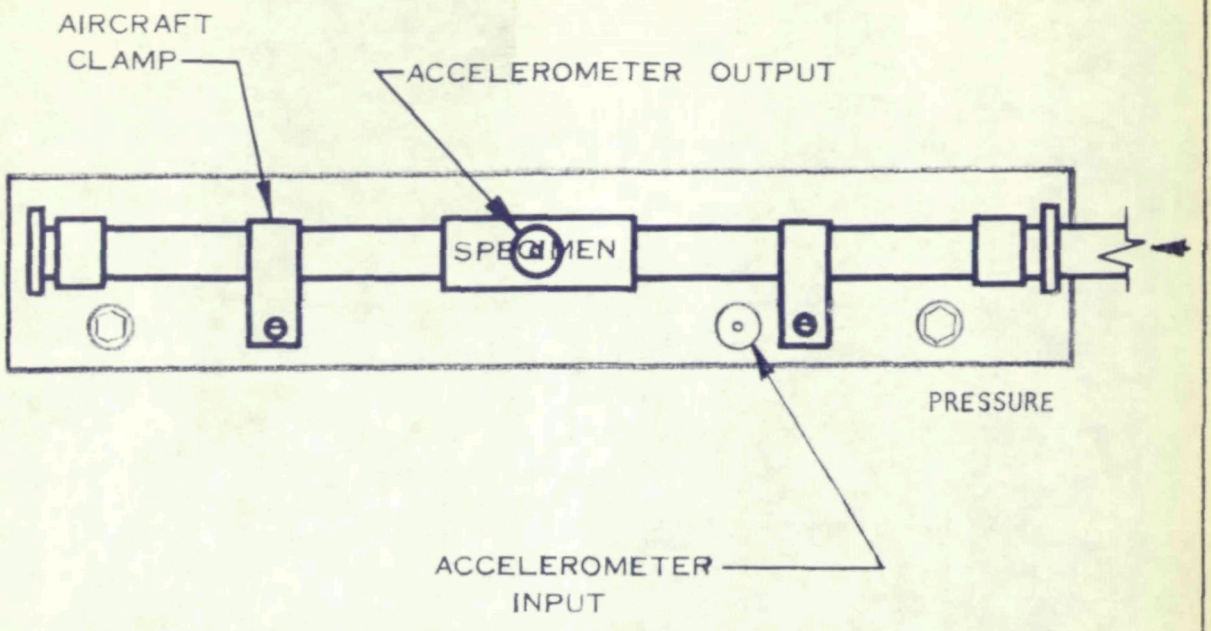
SPECIMEN NUMBER	SPECIMEN DESCRIPTION	AXIS OF VIBRATION	CLAMPING DISTANCE	TEST DESCRIPTION	SPECIFIED VIBRATION INPUT LEVELS		VIBRATION TEST RESULTS	CLAMP USED AND RESULT
NP 10-11-12	SKEL 869-24 1 1/2-In. Tee	(Z)	14 Inches To Center Line Of Fitting	Sinusoidal Dwell	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 to 2000 cps - ±80 g (Peak)		NO FAILURE at 161 cps - 80 g INPUT NO FAILURE at 278 cps - 80 g INPUT	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion
				Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min			NO FAILURE	MS 21919 3/4-In. Wide CRES - Butyl Rubber Cushion. 2 Clamps Failed - Replaced With Silicone Cushion No Clamp Failure
				Random Vibration	20 to 55 cps - 1.5 g^2/cps 55 to 100 cps - 46.0 db/oct 100 to 1340 cps - 5.0 g^2/cps 1340 to 2000 cps - -9.0 db/oct 2000 cps - 1.5 g^2/cps		20 to 100 cps - 49.0 db/oct - 14 g RMS 100 to 350 cps - 5.0 g^2/cps - 35 g RMS 350 to 600 cps - 5.0 g^2/cps - 35 g RMS 600 to 850 cps - 5.0 g^2/cps - 35 g RMS 850 to 1100 cps - 5.0 g^2/cps - 35 g RMS 1100 to 1350 cps - 5.0 g^2/cps - 35 g RMS 1350 to 1700 cps - -9.0 db/oct - 25 g RMS 1700 to 2000 cps - -9.0 db/oct - 25 g RMS NO FAILURE	MS 21919 3/4-In. Wide CRES - Silicone Cushion No Clamp Failure
		(X) & (Y)		Sinusoidal Sweep 5-2000-5 cps at 1.0 oct/min	5 to 32 cps - 0.58-In. D.A. 32 to 76 cps - ±30 g (Peak) 76 to 125 cps - 0.100-In. D.A. 125 go 2000 cps - ±80 g (Peak)		NO FAILURE	MS 21919 3/4-In. Wide CRES - Silicone Cushion. 6 Clamps Failed, Replaced with ADEL 479 Clamp. Failed. Replaced With Solid Alum 2 Hole Clamp. No Clamp Failure



UNION VIBRATION SET-UP

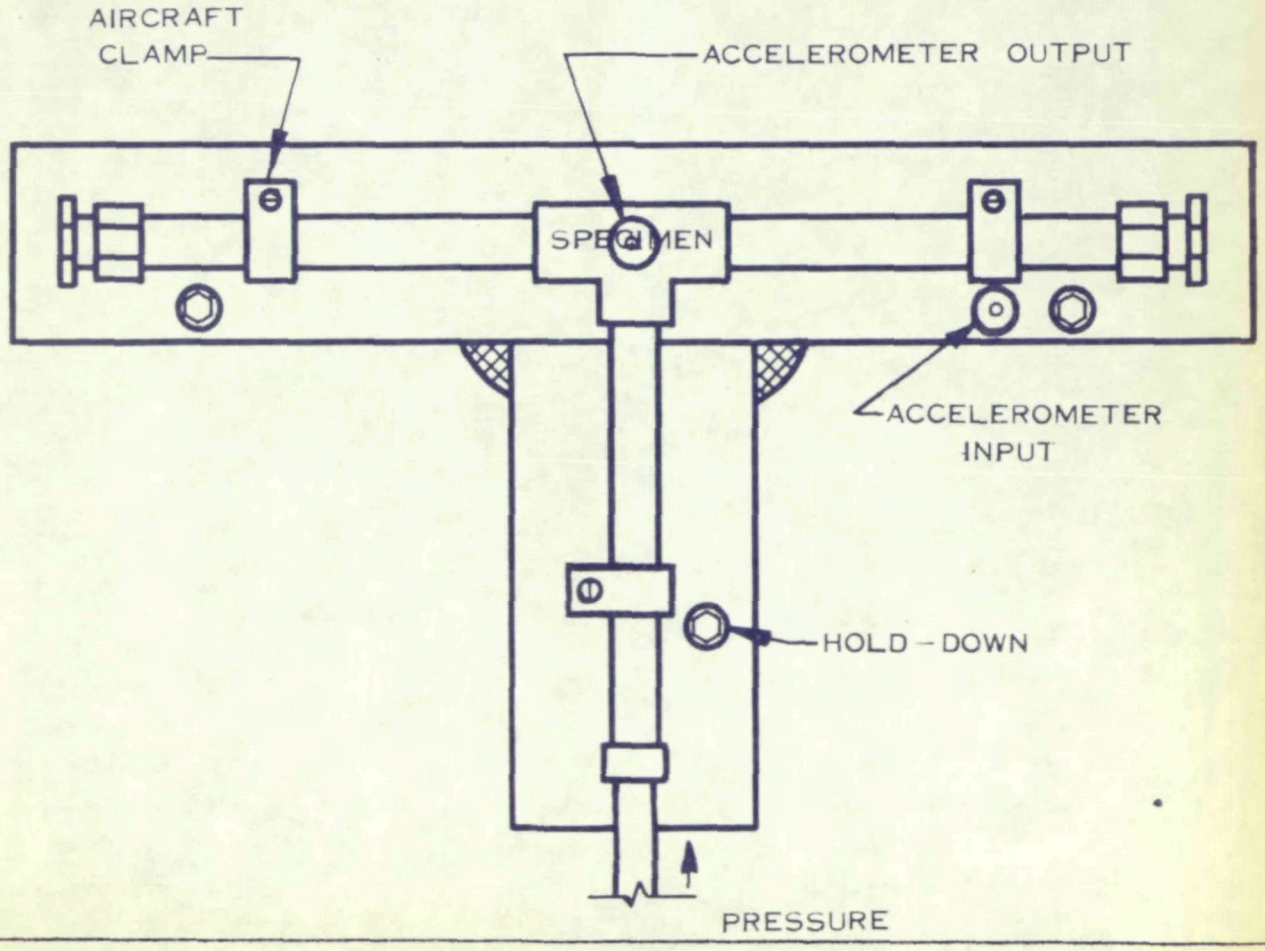
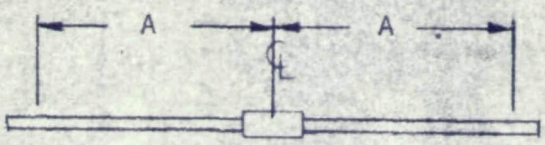
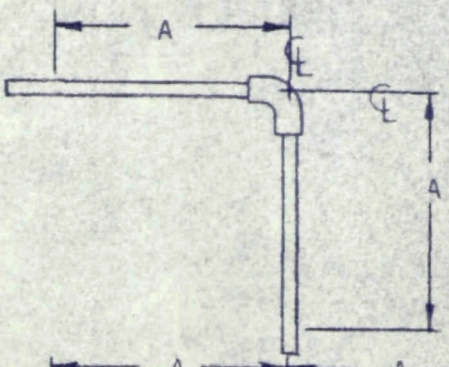


FIGURE 4 - TEE AND ELBOW VIBRATION SET-UP

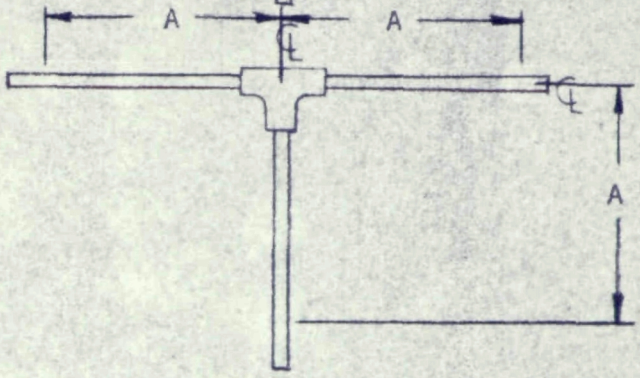
Unions:



Elbows:



Tees:



A = 4-inches

FIGURE 5 - CLAMPING PITCH DISTANCE

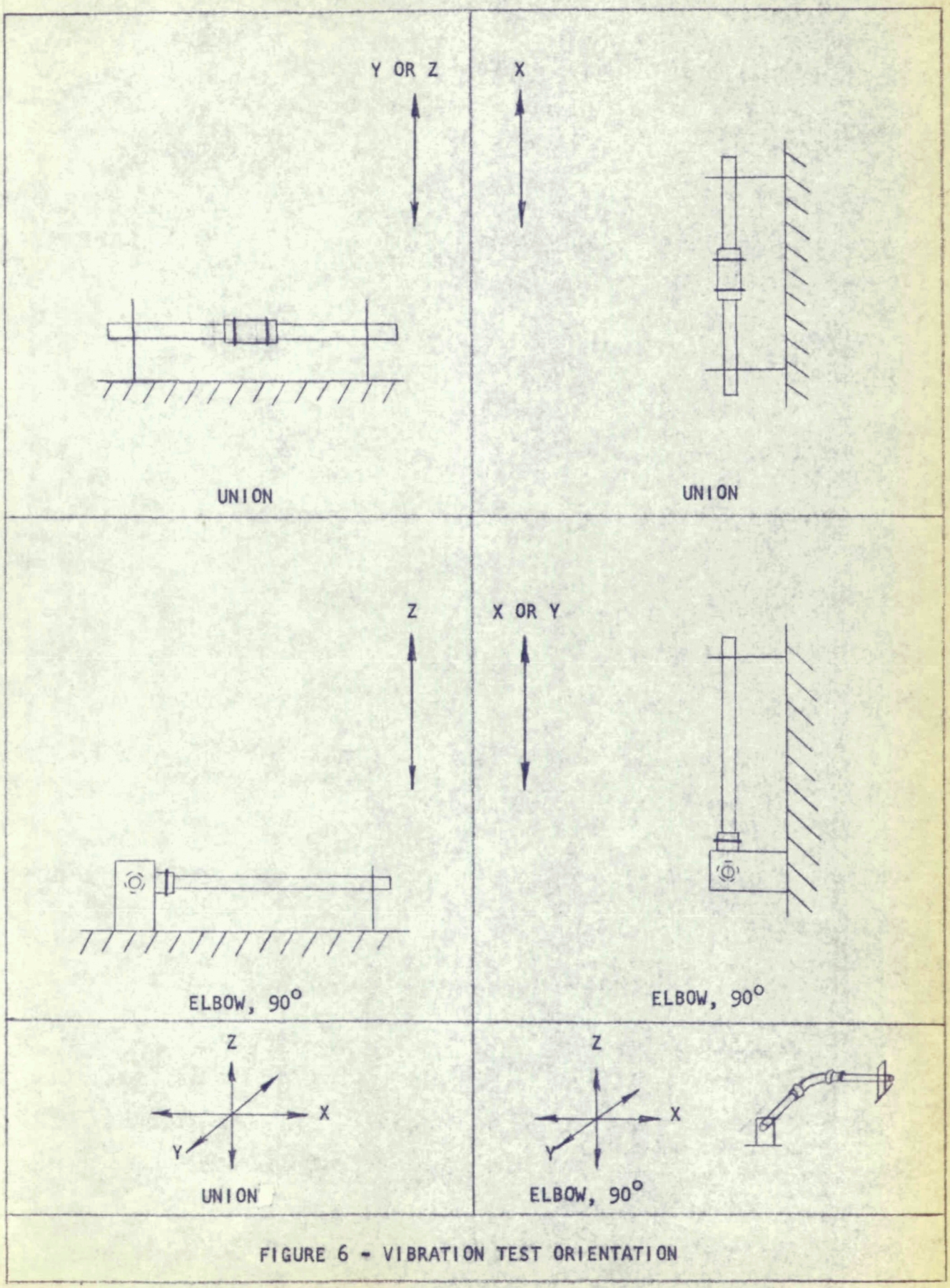


FIGURE 6 - VIBRATION TEST ORIENTATION

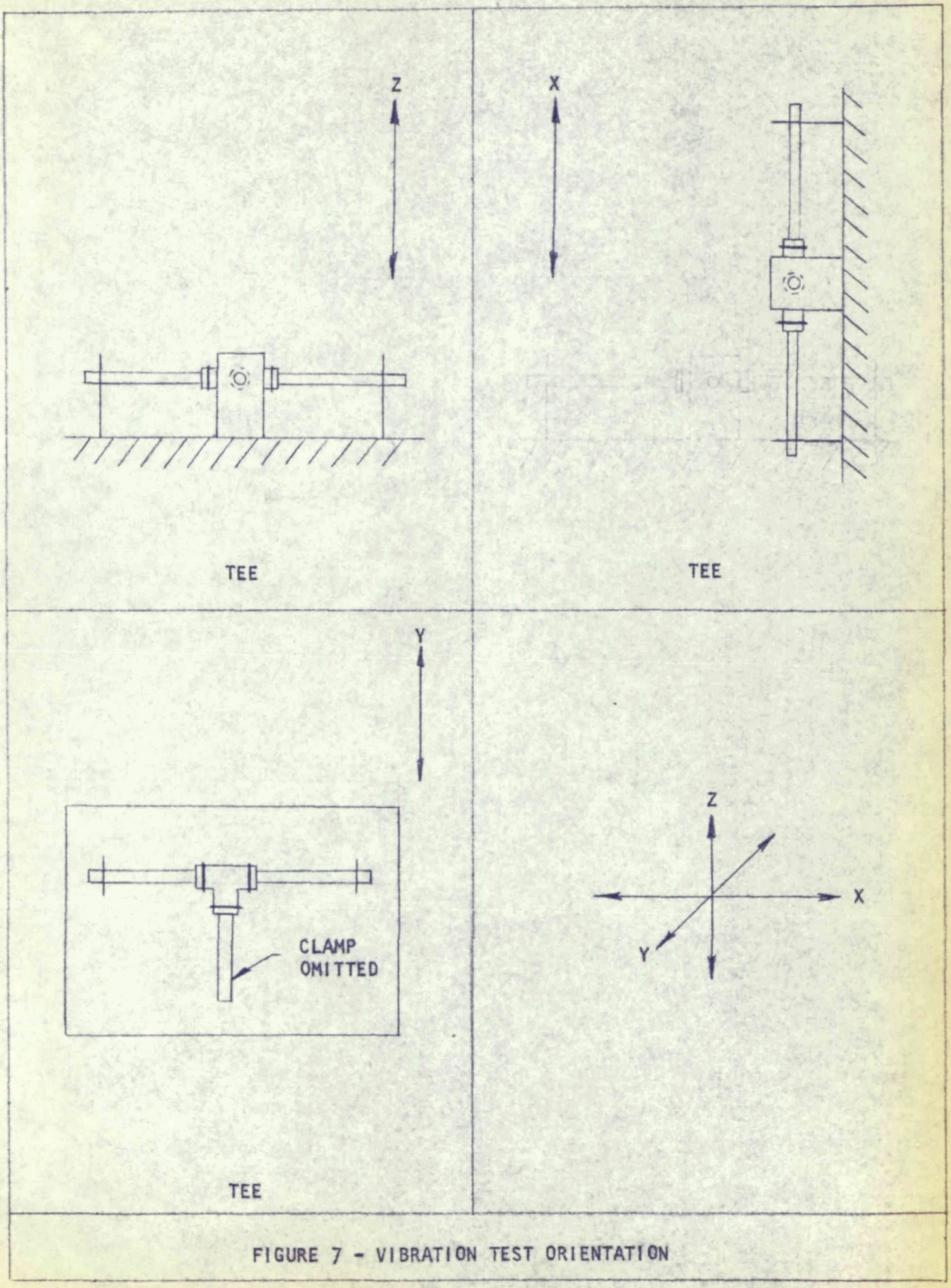
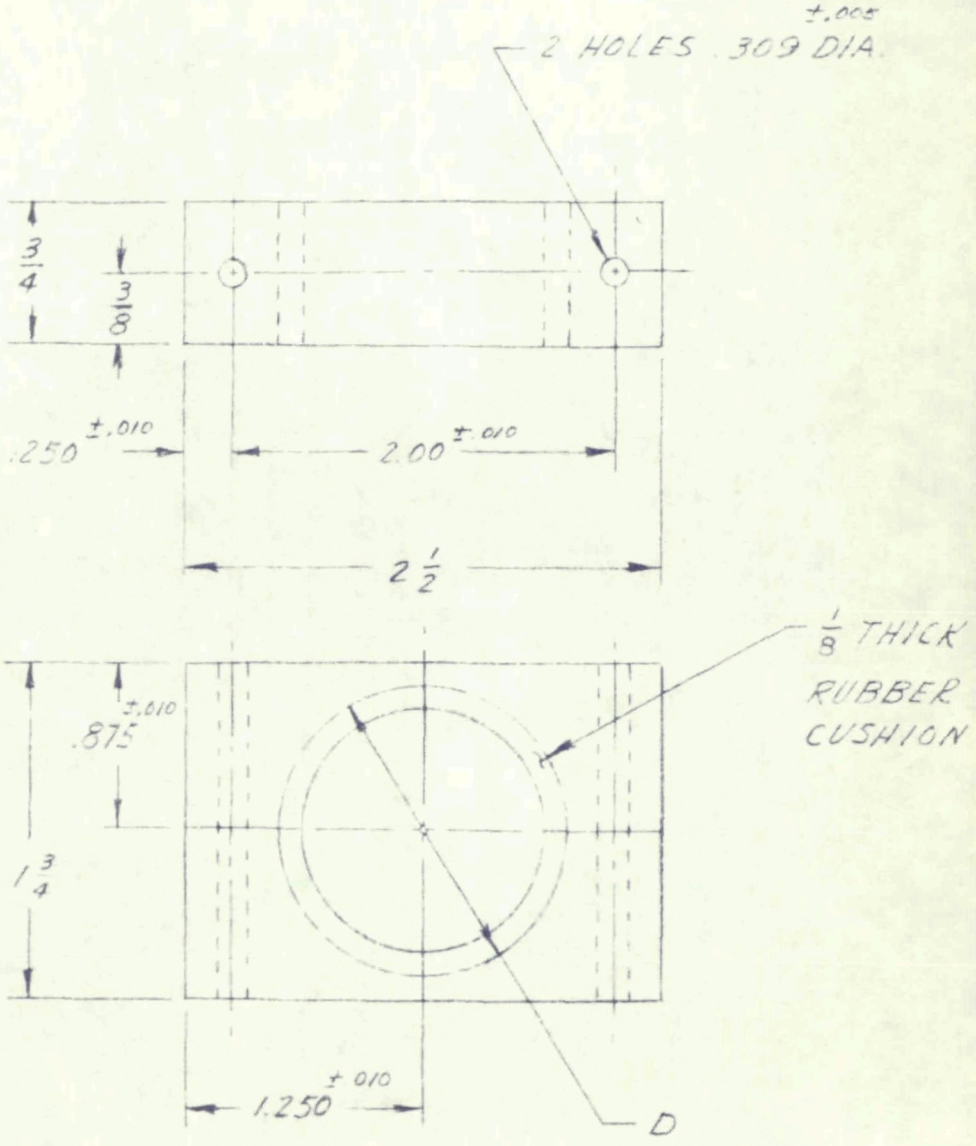


FIGURE 7 - VIBRATION TEST ORIENTATION

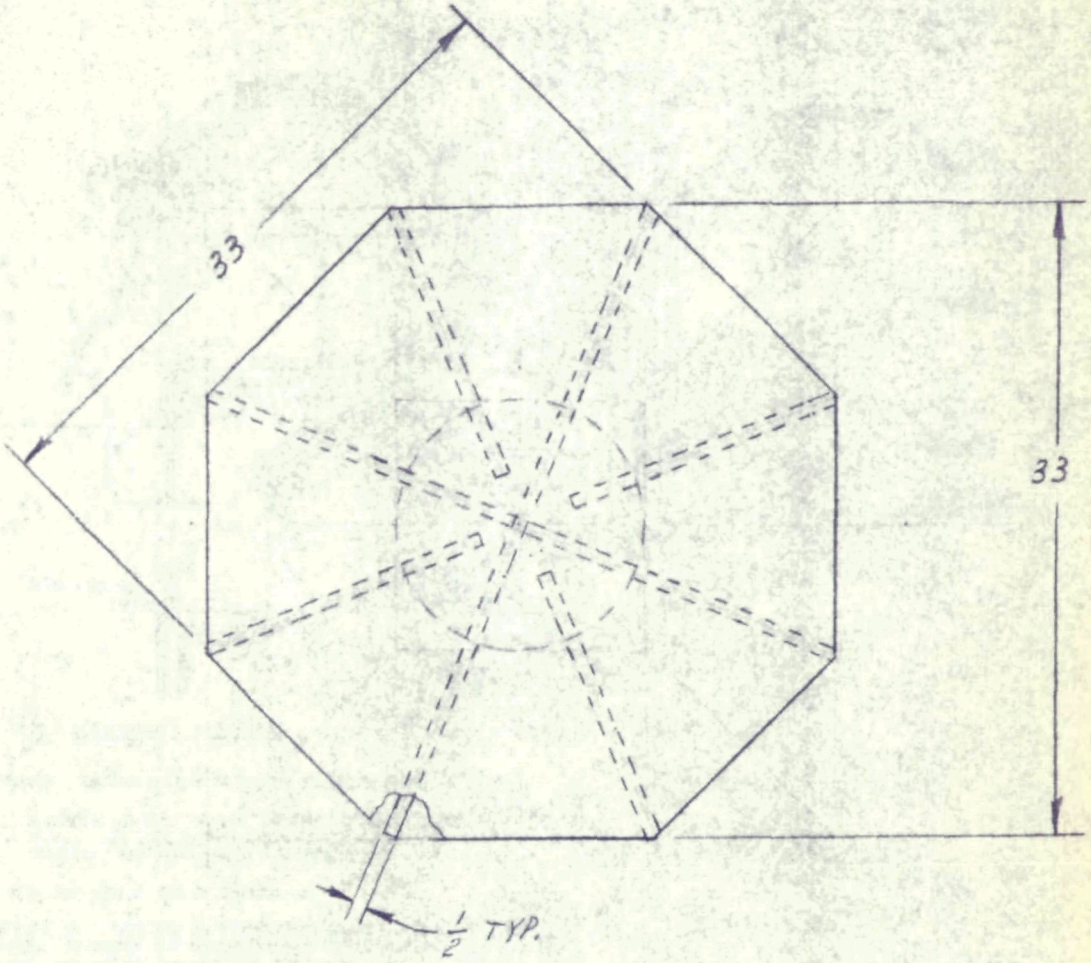
DASH NO	D ±.015
-1	1.250
-2	1.500
-3	1.750

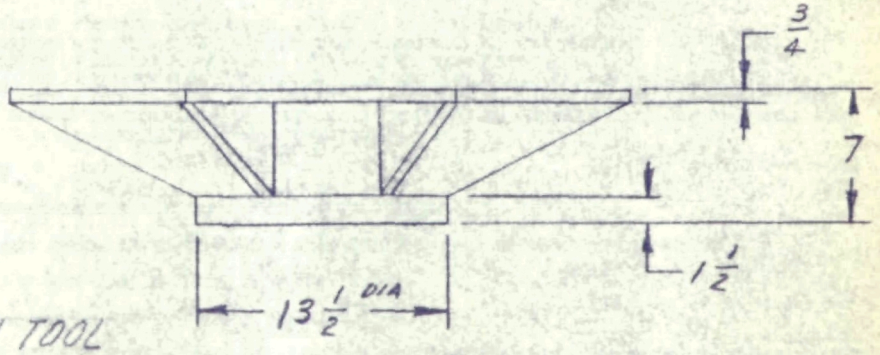
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE ± 1/32



MATERIAL:
CLAMP - ALUMINUM - 2024
CUSHION - BUTYL RUBBER

FIGURE 8 - CLAMP - BUTYL RUBBER CUSHION SKEL 1391



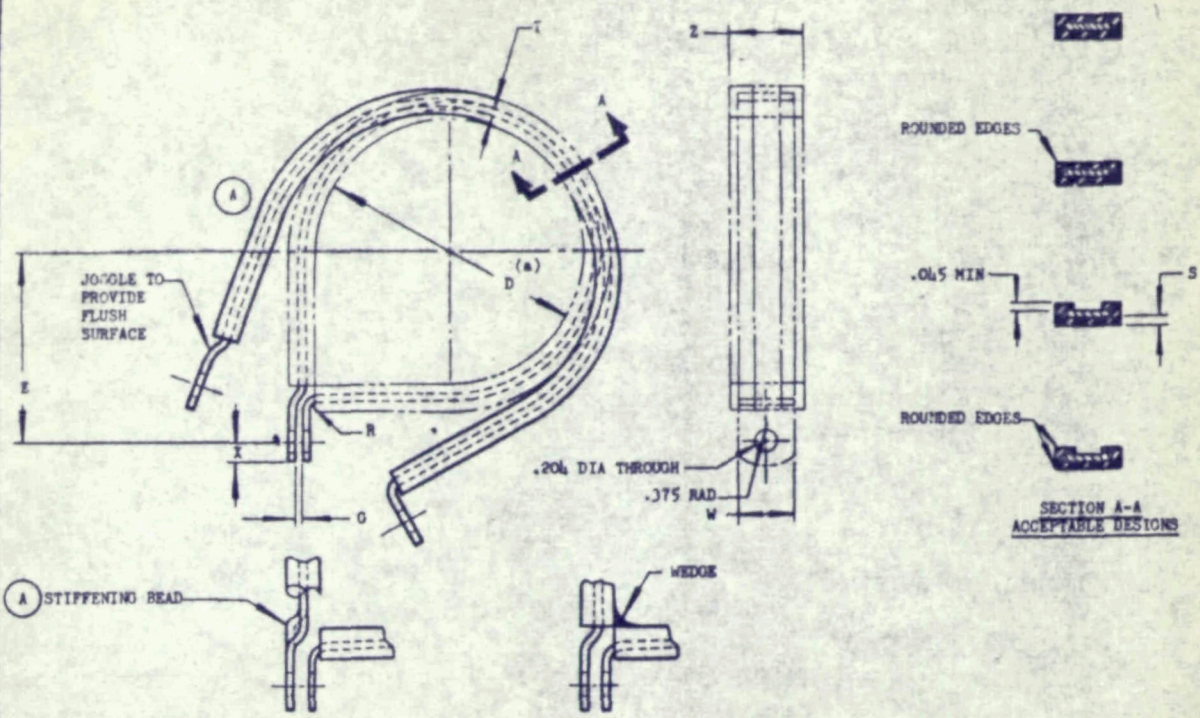


NOTES:

1. MAT'L: DOW TOOL PLATE MAGNESIUM
2. WEIGHT: 70 LBS.

FIGURE 9 - VIBRATION FIXTURE

FED. SUP CLASS.
5340



(A) ACCEPTABLE CONSTRUCTION

(A) (a) DIMENSION D IS APPLICABLE IN CLOSED POSITION ONLY.

MATERIAL: ALUMINUM ALLOY: SEE PROCUREMENT SPECIFICATION.
STEEL: SEE PROCUREMENT SPECIFICATION.
CUSHION: SEE PROCUREMENT SPECIFICATION.

FINISH: SEE PROCUREMENT SPECIFICATION.

ADD D BEFORE DASH NUMBER FOR ALUMINUM-ALLOY CLAMP.
ADD F BEFORE DASH NUMBER FOR FUEL-RESISTANT CUSHION CLAMP.
ADD G BEFORE DASH NUMBER FOR NON-FUEL-RESISTANT CLAMP.
ADD H BEFORE DASH NUMBER FOR HIGH TEMPERATURE (500°F) CUSHION CLAMP.
ADD W BEFORE DASH NUMBER AND ANY OTHER CODE LETTER FOR WEDGE-TYPE CUSHION CONSTRUCTION.

EXAMPLES OF PART NUMBERS:
MS21919F8 - CUSHION CLAMP, STEEL, .500(8/16) ID, FUEL-RESISTANT.
MS21919DF8 - CUSHION CLAMP, ALUMINUM-ALLOY, .500(8/16) ID, FUEL-RESISTANT.
MS21919H8 - CUSHION CLAMP, STEEL, .500(8/16) ID, HIGH TEMPERATURE.
MS21919G8 - CUSHION CLAMP, STEEL, .500(8/16) ID, GENERAL PURPOSE, NON-FUEL-RESISTANT.
MS21919DG8 - CUSHION CLAMP, ALUMINUM-ALLOY, .500(8/16) ID, GENERAL PURPOSE, NON-FUEL-RESISTANT.
MS21919WDG8 - CUSHION CLAMP, ALUMINUM-ALLOY, .500(8/16) ID, GENERAL PURPOSE, NON-FUEL-RESISTANT, WEDGE-TYPE CUSHION CONSTRUCTION.

REMOVE ALL BURRS AND SHARP EDGES.

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: DECIMALS ±.015.

THE MS PART NUMBER, INCLUDING DASH NUMBER, AND MANUFACTURER'S IDENTIFICATION, SHALL BE MARKED ON EACH CLAMP.

THE ENDS OF THE CUSHION SHALL MEET WHEN CLAMP IS IN THE INSTALLED POSITION.

(A) CLAMPS SHALL BE FURNISHED IN THE OPEN POSITION AS SHOWN BY THE SOLID LINES.

(A) FUEL-RESISTANT CLAMPS EMPLOYING RUBBER CUSHION MATERIAL ARE TO BE USED ONLY IN APPLICATIONS WHERE CLAMPS ARE EXPOSED TO FUEL OR FUEL VAPORS UNDER NORMAL CONDITIONS. THIS TYPE OF RUBBER WILL DETERIORATE EXCESSIVELY WHEN EXPOSED TO AIR.

THIS STANDARD TAKES PRECEDENCE OVER DOCUMENTS REFERENCED HEREIN.
REFERENCED DOCUMENTS SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATIONS FOR BID.
THIS DOCUMENT HAS BEEN PROMULGATED BY THE DEPARTMENT OF DEFENSE AS THE MILITARY STANDARD TO LIMIT THE SELECTION OF THE ITEM, PRODUCT, OR DESIGN COVERED HEREIN IN ENGINEERING, DESIGN, AND PROCUREMENT. THIS STANDARD SHALL BECOME EFFECTIVE NOT LATER THAN 90 DAYS AFTER THE LATEST DATE OF APPROVAL SHOWN.

APPROVED 3 Jul 53 REVISED (A) 30 Sep 55

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CUSTODIANS	OTHER INT.	MILITARY STANDARD	MS21919 (ASG)
Navy - BuAer Air Force	A - N - AF -	(A) CLAMP, CUSHIONED, SUPPORT, LOOP-TYPE, AIRCRAFT	
PROCUREMENT SPECIFICATION MIL-C-8603		SUPERSEDES:	SHEET 1 OF 2

DD FORM 672-1
1 OCT 52

FIGURE 10

FED. SUP CLASS. 53.0

MS PART NUMBERS	FIIN	RIGID TUBE NOMINAL OD (REF)	DIMENSIONS D ±.014 DIA	E ALUMINUM ALLOY	E CARBON STEEL	G	R ±.016 RAD	S +.016 -.000	I ALUMINUM ALLOY	I CARBON STEEL	W ALUMINUM ALLOY	W CARBON STEEL	X	Z MAX ALUMINUM ALLOY	Z MAX CARBON STEEL
MS21919-2		1/8	.125	.457	.457										
MS21919-3		3/16	.188	.498	.498										
MS21919-4		1/4	.250	.529	.529				.0320						
MS21919-5		5/16	.313	.560	.560		.062		±.0025			.375	.188		.497
MS21919-6		3/8	.375	.592	.592										
MS21919-7		7/16	.438	.623	.623	.062									
MS21919-8		1/2	.500	.654	.654	+.016									
MS21919-9		9/16	.563	.752	.749	-.000		.045						.622	
MS21919-10		5/8	.625	.783	.780										
MS21919-11		11/16	.688	.814	.811										
MS21919-12		3/4	.750	.845	.842				.050						
MS21919-13		13/16	.813	.877	.858		.109		±.004						.622
MS21919-14		7/8	.875	.908	.889										
MS21919-15		15/16	.938	.939	.920										
MS21919-16		1	1.000	.970	.951					.0320					
MS21919-17		1-1/16	1.063	1.002	.983					±.0035					
MS21919-18		1-1/8	1.125	1.062	1.030										
MS21919-19		1-3/16	1.188	1.093	1.061										
MS21919-20		1-1/4	1.250	1.124	1.092										
MS21919-21		1-5/16	1.313	1.156	1.124										
MS21919-22		1-3/8	1.375	1.187	1.155										
MS21919-23		1-7/16	1.438	1.218	1.186	.094					.500				
MS21919-24		1-1/2	1.500	1.249	1.217	+.031									
MS21919-25		1-9/16	1.563	1.281	1.249	-.000									
MS21919-26		1-5/8	1.625	1.312	1.280										
MS21919-27			1.688	1.344	1.312										
MS21919-28		1-3/4	1.750	1.374	1.342										
MS21919-29			1.813	1.406	1.374										
MS21919-30		1-7/8	1.875	1.437	1.405							.500	.218		
MS21919-31			1.938	1.468	1.444										
MS21919-32		2	2.000	1.499	1.475										
MS21919-33			2.062	1.531	1.507										
MS21919-34		2-1/8	2.125	1.562	1.538		.125	.062	.063					.656	.656
MS21919-35			2.188	1.594	1.570				±.005						
MS21919-36		2-1/4	2.250	1.624	1.600										
MS21919-37			2.312	1.655	1.631										
MS21919-38		2-3/8	2.375	1.687	1.663										
MS21919-40		2-1/2	2.500	1.752	1.728										
MS21919-42			2.625	1.812	1.788	.125				.040					
MS21919-43			2.688	1.844	1.820	+.031				±.004					
MS21919-44		2-3/4	2.750	1.875	1.851	-.000									
MS21919-45			2.812	1.906	1.882										
MS21919-46			2.875	1.937	1.913										
MS21919-48		3	3.000	2.000	1.976										
MS21919-50			3.125	2.062	2.038										
MS21919-52		3-1/4	3.250	2.125	2.101										
MS21919-54			3.375	2.187	2.163										
MS21919-56		3-1/2	3.500	2.250	2.226										
MS21919-58			3.625	2.312	2.288										
MS21919-64		4	4.000	2.500	2.476										
MS21919-66			4.125	2.562	2.538										

THIS STANDARD TAKES PRECEDENCE OVER DOCUMENTS REFERENCED HEREIN.
REFERENCED DOCUMENTS SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATIONS FOR BID.
THIS DOCUMENT HAS BEEN PROMULGATED BY THE DEPARTMENT OF DEFENSE AS THE MILITARY STANDARD TO LIMIT THE SELECTION OF THE ITEM, PRODUCT, OR DESIGN COVERED HEREIN IN ENGINEERING, DESIGN, AND PROCUREMENT. THIS STANDARD SHALL BECOME EFFECTIVE NOT LATER THAN 90 DAYS AFTER THE LATEST DATE OF APPROVAL SHOWN.

APPROVED 3 Jul 51 REVISED (A) 30 Sep 55

CUSTODIANS	OTHER INT.	MILITARY STANDARD	MS21919 (ASG)
Navy - BuAer Air Force	A - N - AF -	(A) CLAMP, CUSHIONED, SUPPORT, LOOP-TYPE, AIRCRAFT	
PROCUREMENT SPECIFICATION MIL-C-8603		SUPERSEDES:	SHEET 2 OF 2

DD FORM 672-1
1 OCT 52

FIGURE 10

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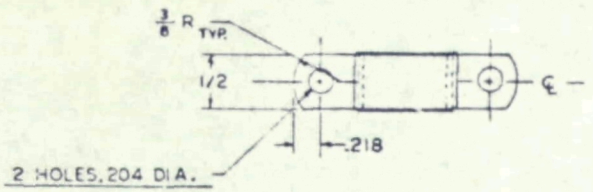
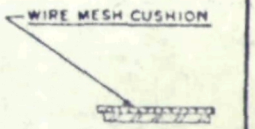
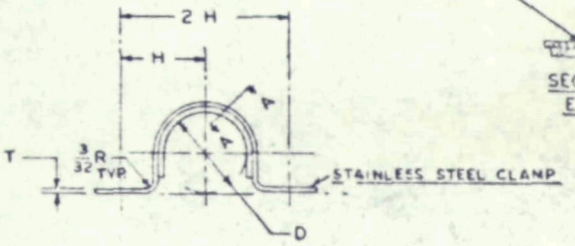
DASH NO.	D ±.015	H ±.015	T
-4	.250	.529	.031
-6	.375	.592	
-8	.500	.654	
-12	.750	.845	.051
-16	1.000	.970	
-20	1.250	1.125	.064







MATERIAL

CLAMP - CRES. ST'L. - AMS 5510

CUSHION - CRES. ST'L. MESH - A.I.S.I. 304

EXAMPLE

479-8 = ASS'Y. FOR 1/2 O.D. TUBE

LET	CHANGE	DATE	BY	APP.

MATERIAL: NOTED

FINISH: NONE | HEAT TREAT: NONE

ADEL PRODUCTS
DIVISION GENERAL METALS CORPORATION

CLAMP - WIRE MESH CUSHION

~~BURNERS~~
✓ CLIPS
~~HYDRAULIC~~

DRAWN: L. H. A. 11-1-65

SCALE: NONE

479

FIGURE 11

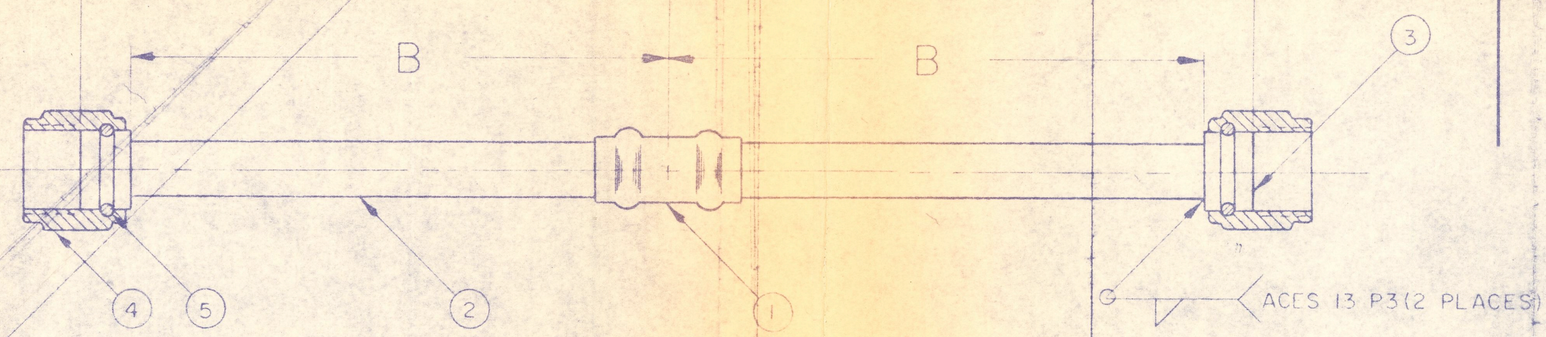
28.4

THE STATE COPY EQUIPMENT - DIETZGEN CO. CINCINNATI

(PAT NO 800)

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL



PART NO.	① UNION	② TUBING (2)	③ SHOULDER (2)	④ NUT (2)	⑤ WIRE (2)	"A"	"B"
SKEL 867-4	AE5062201B2A1	1/4-IN. X .020-IN.	900303-4C	029001-4	900303-1-4C	18.34	18.00
SKEL 867-6	AE5062203B2A1	3/8-IN. X .028-IN.	900303-6C	029001-6	900303-1-6C	18.42	18.00
SKEL 867-8	AE5062204B2A1	1/2-IN. X .035-IN.	900303-8C	029001-8	900303-1-8C	18.44	18.00
SKEL 867-12	AE5062206B2A1	3/4-IN. X .049-IN.	900303-12C	029001-12	900303-1-12C	18.53	18.00
SKEL 867-16	AE5062207B2A1	1-IN. X .065-IN.	900303-16C	029001-16	900303-1-16C	18.53	18.00
SKEL 867-20	AE5062114B2A1	1 1/4-IN. X .083-IN.	900303-20C	029001-20	900303-1-20C	18.59	18.00
SKEL 867-24	AE5062118B7A1	1 1/2-IN. X .095-IN.	900303-24C	029001-24	900303-1-24C	18.66	18.00

DRAWN		DATE
CHECKED		DATE
APPROVED		DATE
APPROVED		DATE
RELEASE		DATE
PROJECT NO.		APC NO.
DESIGN APPROVED		
APPROVED		

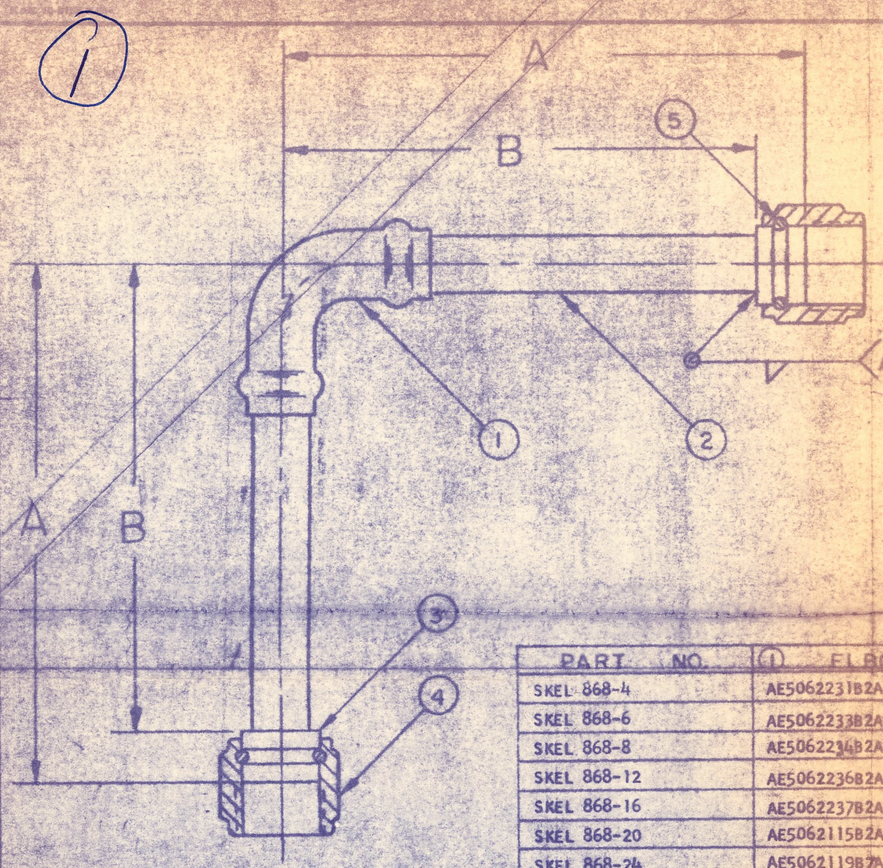
Aeroquip AEROQUIP CORPORATION
AIRCRAFT DIVISION/ELBEECO PLANT
Jackson, Michigan U.S.A.

DRAWING TITLE
TEST SAMPLE
NOMINAL SIZE

CODE IDENT. NO.	SIZE	DRAWING NUMBER
99879	C	SKEL 867

SCALE			SHEET
NONE	W-3	STANDARD SHEET	

FIGURE 1



PART NO.	① ELBOW	② TUBING (2)	③ SHOULDER (2)	④ NUT (2)	⑤ WIRE (2)	"A"	"B"
SKEL 868-4	AE5062231B2A1	1/4-in. X .020-in.	900303-4C	029001-4	900303-1-4C	18.34	18.00
SKEL 868-6	AE5062233B2A1	3/8-in. X .028-in.	900303-6C	029001-6	900303-1-6C	18.42	18.00
SKEL 868-8	AE5062234B2A1	1/2-in. X .035-in.	900303-8C	029001-8	900303-1-8C	18.44	18.00
SKEL 868-12	AE5062236B2A1	3/4-in. X .049-in.	900303-12C	029001-12	900303-1-12C	18.53	18.00
SKEL 868-16	AE5062237B2A1	1 -in. X .065-in.	900303-16C	029001-16	900303-1-16C	18.53	18.00
SKEL 868-20	AE5062115B2A1	1 1/4-in. X .083-in.	900303-20C	029001-20	900303-1-20C	18.59	18.00
SKEL 868-24	AE5062119B2A1	1 1/2-in. X .095-in.	900303-24C	029001-24	900303-1-24C	18.66	18.00

DRAWN		DATE
CHECKED		DATE
APPROVED		DATE
APPROVED		DATE
RELEASE		DATE
PROJECT NO.		APC NO.
DESIGN APPROVED		
APPROVED		

Aeroquip AEROQUIP CORPORATION AIRCRAFT DIVISION/ELBEECO PLANT Jackson, Michigan U.S.A.

DRAWING TITLE
TEST SAMPLE
NOMINAL SIZE

CODE IDENT. NO.	SIZE	DRAWING NUMBER	
99879	C	SKEL 868	
SCALE NONE	W-3	STANDARD SHEET	SHEET

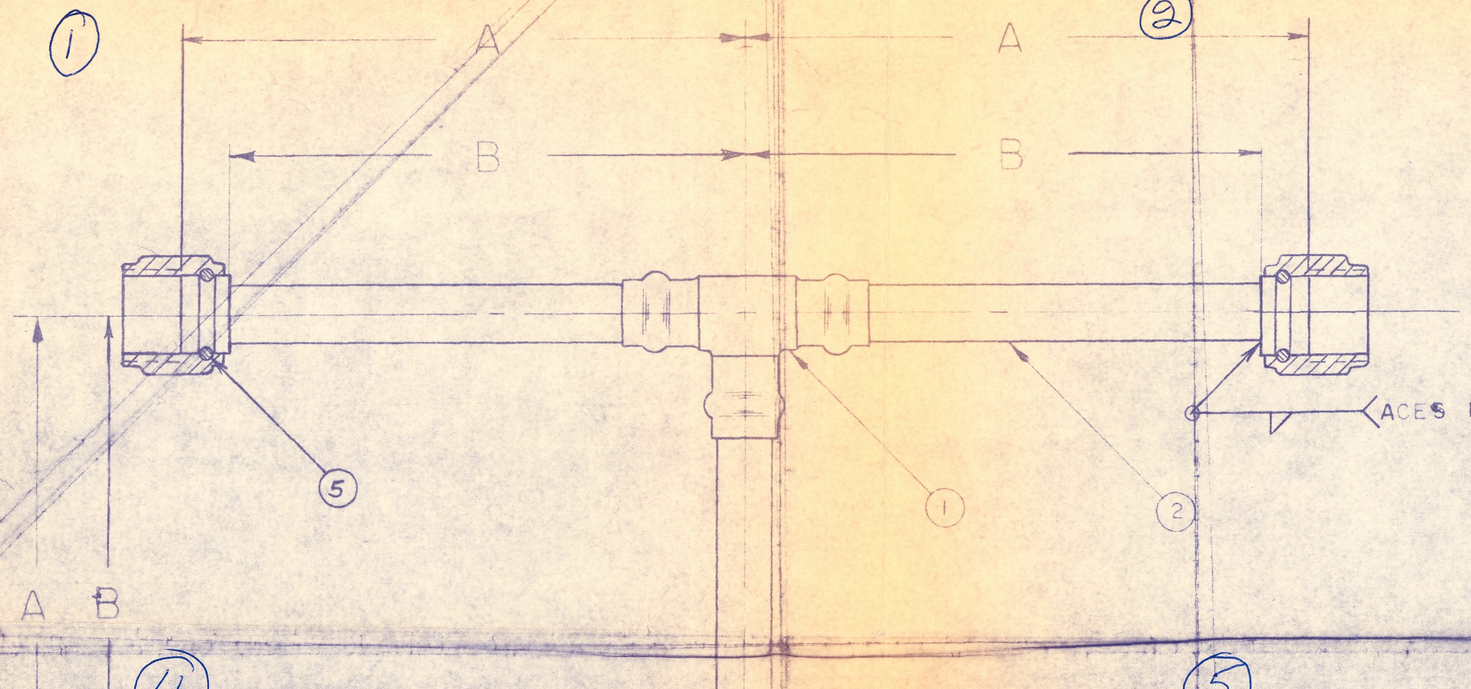
FIG. 2

K&E 10-5155 8-63•

(P.A.T. NO. 800)

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL



PART NO	① TEE	② TUBING (3)	③ SHOULDER (3)	④ NUT (3)	⑤ WIRE (3)	"A"	"B"
SKEL 869-4	AE5062358B2A1	1/4-in.X.020-in.	900303-4C	029001-4	900303-1-4C	18.34	18.00
SKEL 869-6	AE5062386B2A1	3/8-in.X.028-in.	900303-6C	029001-6	900303-1-6C	18.42	18.00
SKEL 869-8	AE5062401B2A1	1/2-in.X.035-in.	900303-8C	029001-8	900303-1-8C	18.44	18.00
SKEL 869-12	AE5062419B2A1	3/4-in.X.049-in.	900303-12C	029001-12	900303-1-12C	18.53	18.00
SKEL 869-16	AE5062428B2A1	1 -in.X.065-in.	900303-16C	029001-16	900303-1-16C	18.53	18.00
SKEL 869-20	AE5062113B2A1	1 1/4 -in.X.083-in.	900303-20C	029001-20	900303-1-20C	18.59	18.00
SKEL 869-24	AE5062117B7A1	1 1/2 -in.X.095-in.	900303-24C	029001-24	900303-1-24C	18.66	18.00

DRAWN		DATE
CHECKED		DATE
APPROVED		DATE
APPROVED		DATE
RELEASE		DATE
PROJECT NO.		APC NO.
DESIGN APPROVED		
APPROVED		

Aeroquip AEROQUIP CORPORATION
AIRCRAFT DIVISION/ELBEECO PLANT
Jackson, Michigan U.S.A.

DRAWING TITLE
TEST SAMPLE
NOMINAL SIZE

CODE IDENT. NO.	SIZE	DRAWING NUMBER
99879	C	SKEL 869
SCALE NONE	W-3	STANDARD SHEET / SHEET

FIG. 3

11 JUL 66 56528

Tooling and related concepts shown herein are proprietary and are covered by pending patent applications

Specifications subject to change without notice.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION/AIRCRAFT DIVISION

ELBEECO PLANT, Jackson, Michigan
WESTERN PLANT, Burbank, California

IN CANADA: *Aeroquip (Canada) Ltd., Toronto, Ontario*
IN GERMANY: *Aeroquip G.m.b.H., Baden Baden-Oos*